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COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

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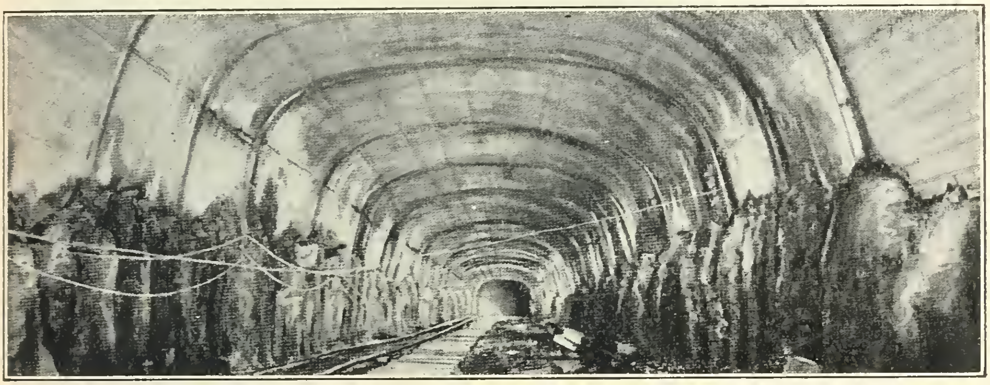


FIG. 1. MOUNT ROYAL TUNNEL. A NOVELTY IN PHOTOGRAPHY

TO GET A GOOD PHOTOGRAPH OF A TUNNEL

We are all sufficiently familiar with photographs of tunnels which cannot be called good pictures and which fail to show the interiors with detail and clearness. Photography underground has been at its best a disheartening job, but we are assured by Mr. J. C. K. Stuart, Assistant Engineer, Mount Royal Tunnel and Terminal Company, in Electric Railway, that with practice and experience results can be obtained in tunnel photography that are almost as good as those obtained by daylight, and with very simple artificial lighting apparatus. The photo of the interior of Mount Royal tunnel here reproduced seems to fully corroborate the statement.

The trick consists in using a portable lamp, with reflector, which is moved along to successively illumine all parts of the interior which is to be photographed. The camera needs no description—almost any type will serve—but an anastigmat lens of the cemented type will give negatives that are more brilliant than a lens of the air-space type under tunnel conditions. There is no need for a large aperture. Most of the photographs used by Mr. Lancaster, who has been most successful in this work, were taken with the lens stopped to full. The plates must be backed or double coated. The lighting apparatus consists of a 1,000-watt, 110-volt, tungsten, concentrated filament lamp mounted in a mirror reflector, designed in such a way that the light from it is very evenly diffused, with no concentrated ray, but only one small dark spot in the center of the circle of illumination. The reflector and lamp are shown in Fig. 3.

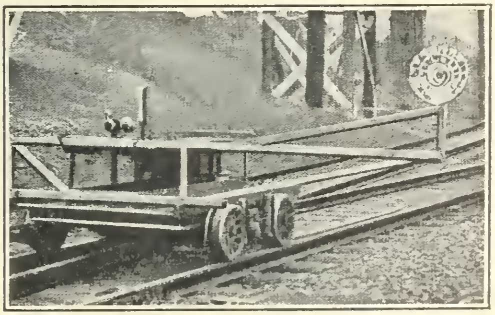


FIG. 2. CAR AND LAMP

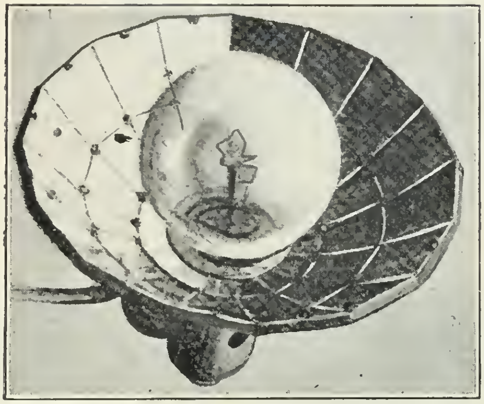
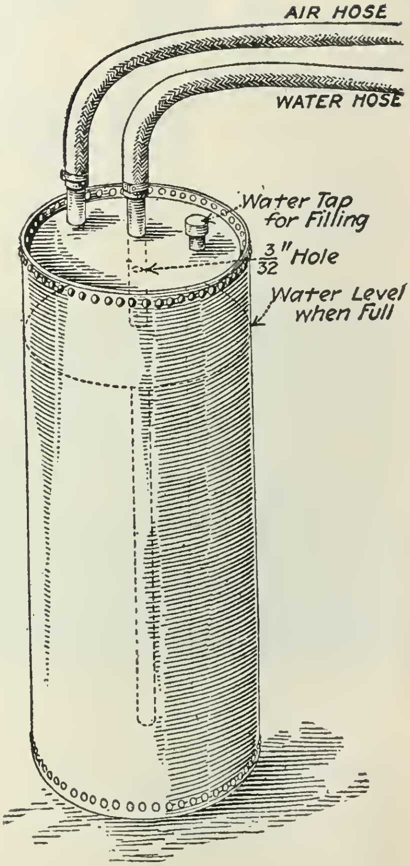


FIG. 3. LAMP AND REFLECTOR

To obtain a long perspective of a tunnel the lamp must, of course, be carried down the tunnel ahead of the camera and pointing away form it, thus illuminating every part of the tunnel successively, starting directly in front of the camera and ending, say, 1,000 ft. from it, or whatever distance is required in the photograph. The lamp may be carried in the hand and current fed to it by a wire of the required length attached to the tunnel lighting system, but for long perspective views it is better to mount the lamp on a small push car connected to an electric locomotive about 250 ft. away by means of a light rope and a wire for furnishing the current to the lamp. The man attending the lamp must keep his body between the lamp and the camera, or else the light from the ventilating holes in the socket will strike the lens.

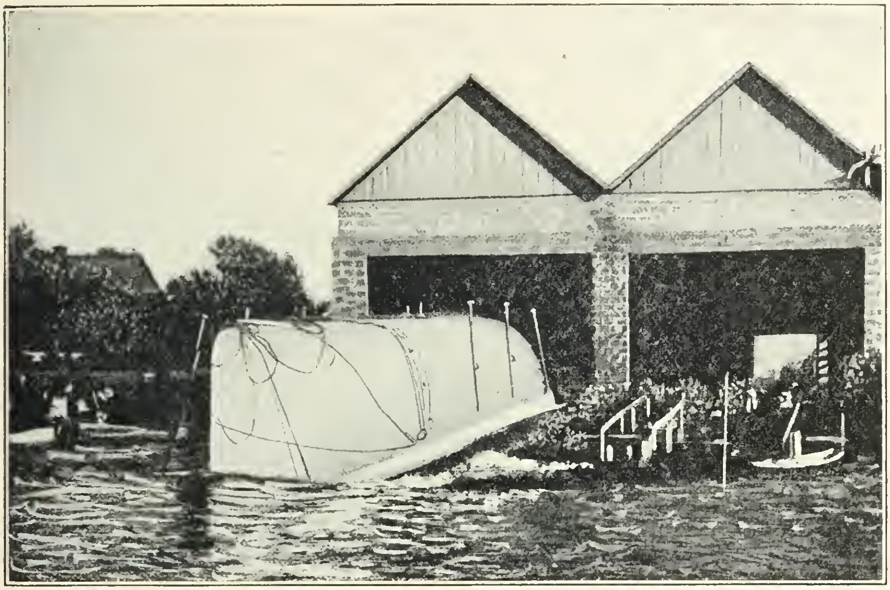
If any hitch occurs during the taking of the photo, such as the catching of the wire in the track, necessitating a stop, the lamp man puts out his lamp until all is clear, lighting it again as soon as he starts to move on.

A few experiments will give the right speed of the lamp for the correct exposure of the plate for different sizes of tunnel, but as the distance from the camera to the lamp increases the speed at which the lamp travels must increase.



AIR AND WATER TANK FOR MACHINE DRILLS

The common form of tank for supplying water to machine drills may be improved by a simple alteration that makes the water supply to the drill hole more effective in blowing out the sludge. In ordinary operation when the tank is filled with water and the drill running the air pressure in the tank forces the water through the water hose to the drill and into the drill hole. While the water is effective in allaying dust and will wash out holes in hard ground which point upward, the pressure is not strong enough to clean downward-pointing holes, or holes in ground that makes a sticky sludge. To remedy this, a simple change was made, which works satisfactorily and is shown in the accompanying illustration. A $^3/_{32}$-in. hole was drilled in the water-feed pipe above the highest water-level, so that as the air pressure is applied to the tank, bubbles of air enter the water as it passes through the pipe to the drill. These bubbles of air burst when they reach the bottom of the drill hole

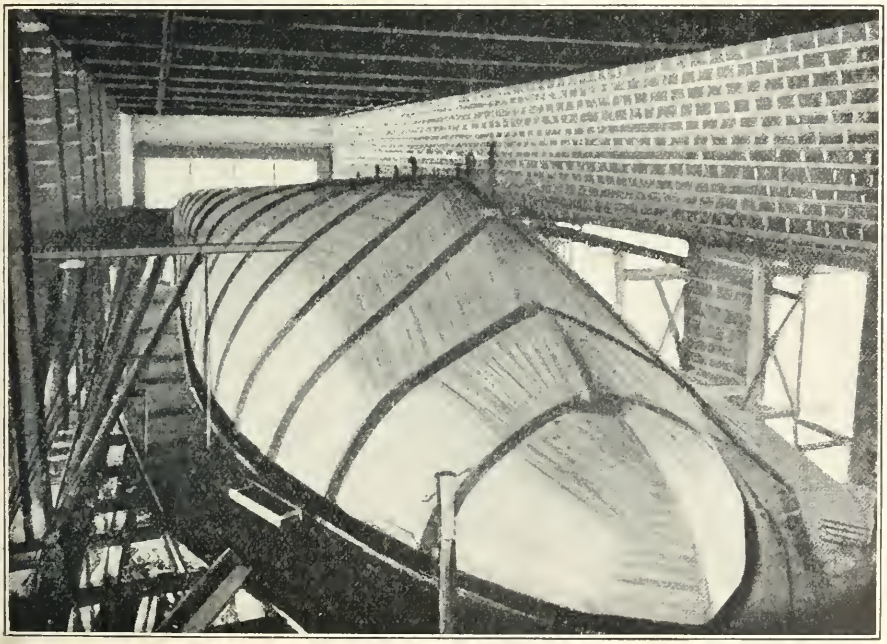


THE LAUNCHING OF THE CONCRETE SHIP

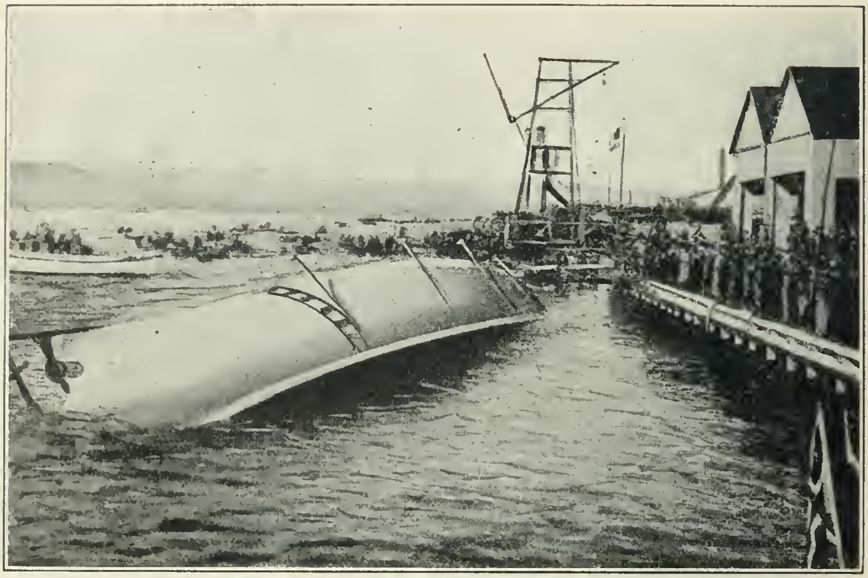
and the mixture of air and water is more effective in throwing the sludge out of the hole than the water alone. The hole in the water pipe must be small in order not to admit too much air, which would reduce the pressure on the water.—*Eng. and Mining Journal.*

THE LAUNCHING OF A REINFORCED CONCRETE SHIP

Whatever might be our belief as to the practical value of reinforced concrete for the hulls of ships, the problems involved in their construction could not fail to be of interest, and



MOLD FOR INTERIOR OF SHIP



BEGINNING TO TURN

our readers, we doubt not, will welcome the half-tones on the opposite page. The photos were taken at Porgrundo, Norway, in August, 1917, and they show us the final incidents in the launching of the Beton, a reinforced concrete motor ship of 200 tons.

This ship was built not in the normal vertical position but with the keel on top, the advantage of which so far as the constructive operations were concerned, must be sufficiently evident. A mold the shape of the interior of the hull was built of wood and upon this the interlacing steel reinforcement was placed and then the concrete was poured to the required thickness, a very simple operation. The mold was built upon a broad, flat surface and as the mold and hull were launched together the usual difficulties were avoided. Then came the operation of turning over the hull to bring the ship right side up, and the pictures tell the story of this without much call for words of explanation.

The mold was divided into a number of closed side compartments with an open space in the center, and by admitting water on one side while retaining the air or increasing the air volume on the other side the preponderance of weight soon turned the hull over to the required normal position. The water was then pumped out, the mold was removed and the operation was complete. The righting of the hull after the launching required only fifteen or twenty minutes.

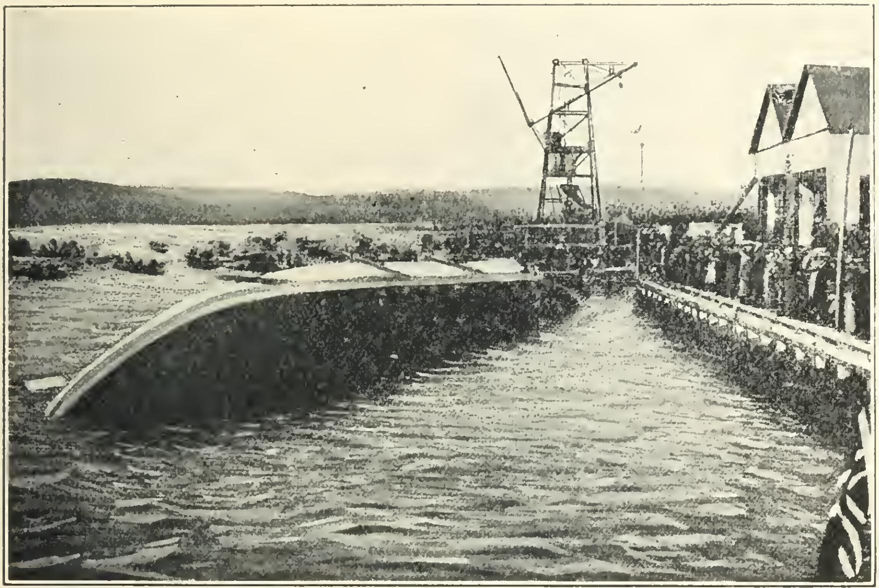
SPEEDING UP THE DRILL

There has been considerable discussion and much earnest effort in attempts to get more work out of machine drills. There are many ways in which this may be accomplished, but there are also many obstacles when it comes to active practice. It is the object of this article to briefly outline some of these methods and to describe one in particular.

In analyzing the cost of breaking rock it has been found that the greatest item of expense is miners' labor, and the labor situation of today is such that it is poor policy to try to get any more work out of a man. The only way out of the difficulty is to make possible for a man to do more work without expending any more energy. In view of such considerations methods of speeding up the drill seem to offer the best solution and these group themselves under the following head: (1) Increasing the actual drilling time of the machine. (2) Increasing the reciprocating speed of the machine.

ACTUAL DRILLING TIME

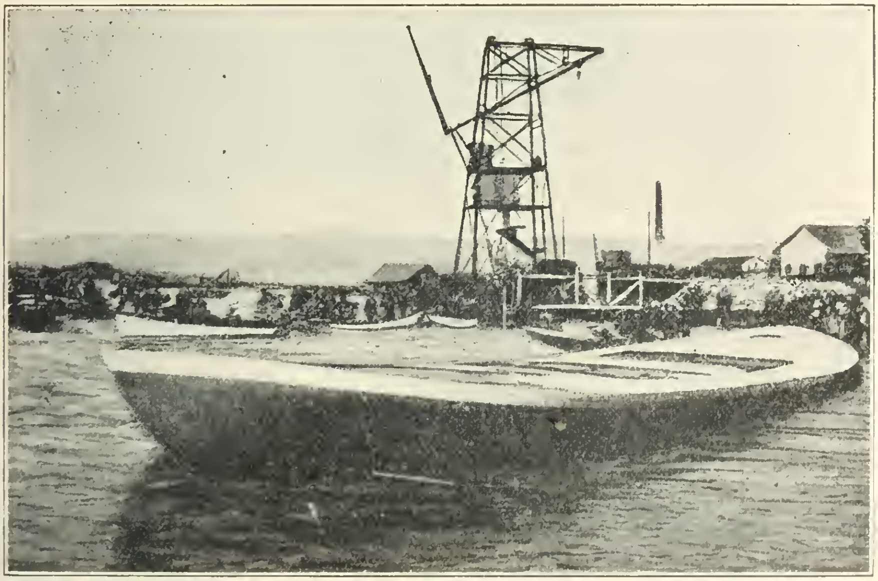
The importance of the first factor is realized by few. A little time spent with the stop watch will show that machines are actually operated from 25% to 50% of the total shifts' time, or



HALF WAY OVER

from two to four hours of the customary eight. Personally, I have never known one to run as high as four hours out of eight. The rest of the time is spent in various other operations, such as "mucking back," mounting, changing drills, moving the machine, tearing down, loading and firing the holes, etc. All these things have to be done by the miner and take up a large part of his shift.

The diminution of such delays in drilling must be made according to the conditions in various places. In a general way only a careful study of delays will suggest remedies. In many cases lighter machines and mountings



READY TO BE PUMPED OUT

can be used to advantage. In drifting the miner's greatest delay is mucking out a place for his post. Where there are two 6- to 8-ft. wide drifts not too far distant on the same level, the following is a good time-saving method:

Instead of using one machine per shift in each drift, work both machines in one drift on the day shift and move them to the other on the night shift. In the mean time the first drift is mucked out and ready for a clean start on the following day shift. This adds from one to two hours to the available drilling time. Needless to say, the miners are glad to be relieved of the strenuous mucking at the start of the shift. There is no additional labor involved in this arrangement and it is only impracticable where the ground is so soft that there is not enough drilling in a round of holes to keep two machines busy for a shift. Careful attention to the supply and quality of drill steel will also help to increase the machine's running time. These are merely suggestions and may not apply in all cases. Some day the rock-drill manufacturers will devote more time and study to the designing of a machine that will facilitate the changing of drills and other operations that mean lost motion to the miner.

RECIPROCATING SPEEDS

In the second method of speeding up the drill it is evident that, if a machine is only reciprocating from two to four hours in a shift, everything should be done to get a maximum amount of hole drilled in that time. This means a close study of different types and makes of both machines and drills to determine what is best suited to the ground. There are several makes of machines on the market as well as a diversity of opinion as to which are best. That is a question that can only be decided by experiment in each case. The same applies to various types of drill bits. Of course, a small hole can be drilled faster than a large one and here we have the big advantage of the Carr bit with its small gage changes. On the other hand, a small hole will not hold so much powder. In the latter case the solution is either to use stronger powder or place a smaller burden on each hole. The powder solution is preferable, of course, but there are mines where the ventilation is too poor to care for the larger volume of fumes that come from powder of greater strength.

AIR PRESSURES

There is one thing that will increase drilling speed in all cases and that is getting every available pound of air pressure behind the hammer. Pressure-drop through pipes, hose, inlet ports, etc., has been carefully measured and recorded, but there are still a surprisingly large number of mines where no attention is given to such matters. To put the loss in drilling speed into something more tangible than merely the pounds drop in pressure, an interesting test was conducted.

A place was selected where there were two machines in good condition, supplied with air through oversize pipes to insure a maximum pressure. A glove valve was inserted in the pipe line near the machines, and a pressure gage attached between the valve and the machines. For an entire shift the pressure was kept down to 55 lb. by manipulating the valve, and the drilling speed of the machines recorded in the usual manner. The next day the test was repeated with a constant pressure of 70 lbs. This 15-pound increase in air pressure increased the drilling speed by 37 per cent. By drilling speed is meant inches drilled per minute of actual reciprocating time. The result obtained was almost startling although the test was simple and easily performed. A 15-lb. drop in pressure is quite common in conducting compressed air through pipes, but a difference of 37% in drilling speed is enough to make anyone "sit up and take notice." In this particular case it led to a careful investigation and to the adoption of certain standards in regard to minimum size pipes, hose, inlet ports and connections. The air-pipe equipment of each level was carefully worked out so as to comply with a fixed maximum permissible drop in pressure.—*Eng. and Min. Journal.*

More than 400,000,000 ft. of Southern pine (approximately 20,000 carloads) has been purchased by the Federal Government through the Southern Pine Emergency Bureau for the war needs of the nation here and abroad, according to figures compiled by the Bureau. This is additional to about 375,000,000 ft. of timber being placed through the Bureau for the construction of 250 ships. The total makes by far the biggest lumber order in the history of the world.

AIR DRIVEN PORTABLE COLUMN HOISTS

BY L. H. HICKS

A detail of mine operating costs which has commanded considerable attention recently is the man-power cost of hoisting, handling and hauling light loads. That machines be substituted for men on odd jobs and temporary work as well as on the more important mining operations is highly desirable in view of the increasing wage demands. Many needs for portable power have been met by the mine column hoist, which is compact, easily installed and air operated. Mining men in general have become well acquainted with these little machines, Fig. 1, in hoisting the light loads incident to the sinking of a winze or driving a raise. Hauling cars in and out of small drifts is also a common application, but there have developed recently a number of unusual and interesting ways of applying these portable hoists.

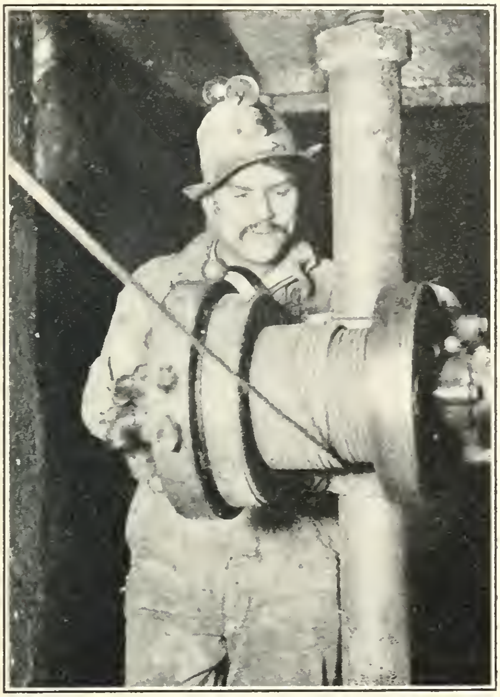


FIG. 1

In sinking prospect shafts column hoists have been used to handle nearly everything, as the little two-drill compressor commonly used supplies plenty of power for hoisting when the drills are not working. In the larger sinking operations these hoists have been used to handle sinking pumps, for hoisting the drilling machines before shooting, and to put piping, conduits, etc., in the shaft. In winzes and raises they handle drills, steels, powder, timbers and muck—and men, too, when the bosses aren't around. As auxiliaries to the regular mine hoists needed in the larger winzes,

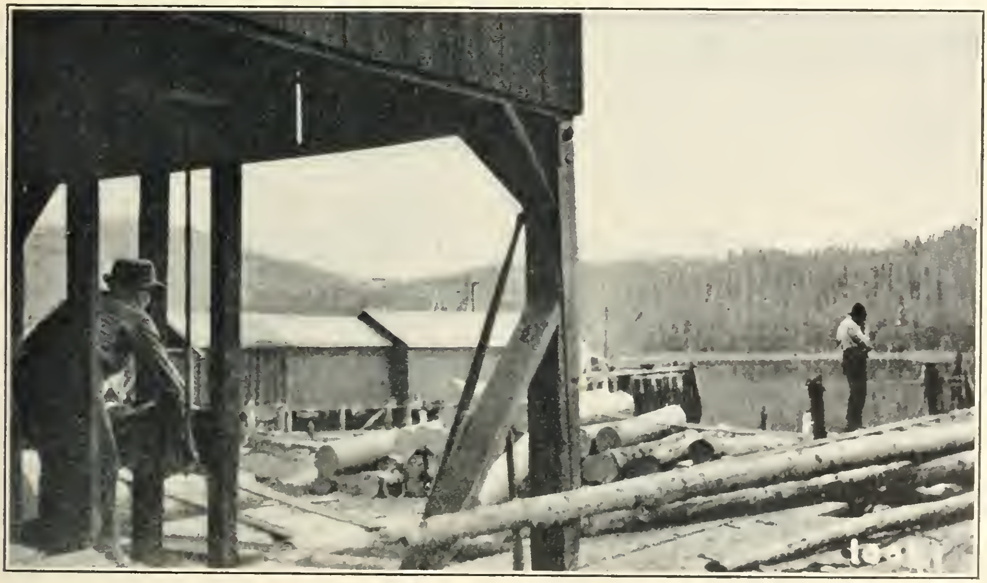


FIG. 2

column hoists have proved labor savors in bringing the rope back to the bottom which, when done by hand requires several men. One little hoist, bolted to a truck, is transported through a Butte mine for all sorts of odd jobs.

The Alabama red-ore mines employ column hoists in drifts where the grade is too steep to push an empty car by hand or to haul it with a mule and the down grade is not sufficient to keep the cars moving by gravity. In some of the Michigan mines where it is necessary to move the tram cars on 30° slopes between levels, hauling up empties and lowering loaded cars, the work is efficiently done by these small machines which handle some remarkable loads. At an Illinois mine they haul loaded cars, weighing 2,500 lb. each, up a 30° incline, and in New York two 8½-ton cars up a 6% grade.

Pulling timbers from old workings is another field in which one man with a column hoist can do as much as from two to six workmen. Most of the machines use wire hoisting rope, but at Butte there is a strong preference for manila. The uses of column hoists above ground are, if anything, more varied than under ground, ranging from removing dirt from a foundation excavation to driving a tumbling barrel by belt from the rope drum. In the latter case, drill steel is tumbled to clean it for electric welding. At an Alaskan mine a Little Tugger hoist, Fig. 2, is used at the sawmill for hauling logs from the water up the beach to the lumber pile, and then to pull the logs along in front of the saw. There are reports of similar hoists handling heavy mine timbers at lumber piles in other districts. One of these machines has been utilized at another mine in Alaska to pull 50-lb. steel rails through a rail bender, as already described in the *Journal*. At stlll another mine, all the fuel oil and supplies are hauled up an incliune tram with a column hoist, as labor is too expensive.

At a mine in Cuba two of the hoists have been placed on locomotives and are used to haul cars in and out of sidings to save switching the locomotive itself. This, however, might not be considered practicable in many cases. To prevent the flow of water into a mine in Arizona dozens of holes were drilled to bedrock and slime was pumped in under pressure. The slime "sets" like cement, and it was believed that a portion of the faults could be filled up and the pumping costs reduced. The drilling rig Fig. 3 was similar to a churn drill, the actuating power being a portable column hoist. The string of 3-in. tools was raised by the hoist and allowed to drop of its own weight and by this method 30-ft. holes were satisfactorily sunk.—*Eng. and Min. Journal.*

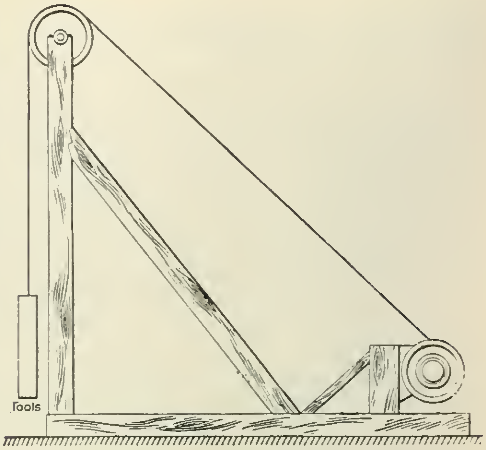


FIG. 3

ECONOMY OF TIGHT AIR HOSE CONNECTIONS

BY GLENN B. HARRIS

In the use of compressed air it is essential that tight joints be maintained, not only throughout the pipe line, but at all hose connections on the latter, and the connections between the hose and the tools being operated. This is necessary not only that the tools receive air in proper volume and pressure for their efficient operation, especially where compressor capacity is deficient, but also as an economic proposition of no small magnitude.

When it is taken into consideration that 5 cu. ft. of compressed air at 80-lb. pressure will flow through a $^1/_{16}$-in. opening in one minute, and that it requires one horsepower for the production of the amount of air named at the pressure given, the expediency of conserving the air supply in all ways possible is self-apparent.

In some plants attention is given to this feature of economy, while in others it remains uncared for, and absolutely neglected.

Pneumatic tools, as a rule, are operated by unskilled laborers who know nothing of compressed air, except that it makes their machine go. They know nothing of its cost of production, and care less. If there is a leak present at their machine, they make no effort to prevent it, nor trouble to report it.

In small shops where the number of tools in operation is comparatively few, the foreman should make it a part of his daily duties to inspect all hose and hose connections, and also the iron pipe line, to ascertain as to their tightness. Frequently the globe valve on the iron pipe line is not tightly turned down to its seat, then, too, grit or scale may be present to prevent the proper seating of the valve, or the valve itself may be leaky. Any of these causes contribute to unnecessary waste of air, and as shown this unnecessary waste is an expensive proposition, especially in large plants, where hundreds of pneumatic tools are in operation, and practically miles of piping employed in order that the tools may be utilized at convenient points.

In most plants, where a very large number of pneumatic tools are employed, it is usual to detail one man whose sole duty it is to inspect the pipe lines, valves, hose and hose connections and couplings to see that leaks are not present, and if so to immediately give them proper attention. This should be the practice in all plants of any considerable size. The expenditure for this inspection may seem an unnecessary one, but it will be found a paying proposition in the long run.

LOOKING FOR LEAKS

A leak at the joints can be readily accertained by applying a torch, or by the application of a small quantity of water, which latter will of course bubble if there is an escapement of air.

In looking for leaks at the tool end, the tool should be stopped by closing its own throttle. The leak if present will be readily apparent by the sound of the escaping air, although probably the surest means which can be employed are the torch or water.

If leaks are located in the hose lines it will prove profitable to immediately cut out the leaky portion and couple up by means of pipe nipples. If the hose becomes worn or leaky to the extent that a number of connections are required, it will prove economical to dispose of the leaky section or sections.

A first-class quality of hose and rubber tubing should be employed, while it may be expensive in first cost, it will prove cheaper in the end than hose purchased at a low price. The latter as a rule will develop leaks in a brief period of time, and will quickly rot out under weather conditions. In addition to this it is so loosely put together, and the materials employed are of such poor quality, that it will not withstand the air pressure of from 80 to 100 lb. per sq. in., at which pressures pneumatic tools are most generally operated.

THE QUALITY TO USE

As before stated, the hose and tubing should be of first-class quality, and the long sections should be wound with galvanized wire, which will serve as an efficient protection against abrasion or cutting in dragging around the shop or yard. It should be at least six-ply, and the tubing which connects the tool with the long length of hose should be oilproof on its interior surface as the lubricant is usually introduced to the tool through this short section of tubing.

If a poor quality of hose or tubing is used it will hardly be possible to obtain the best results from the pneumatic tools. Delays will occur due to the periodic closing of the ports by the accumulation of rubber in the air passages.

It requires an expert to detect the difference between good and poor hose, and even the best of it undergoes a continuous deterioration in value.

The short section of rubber tubing is employed in order that flexibility of the tool may be obtained, and as much weight as possible removed from the operator. This short section of tubing remains, so to speak, a fixed part of the tools to which it is connected.

THE COUPLINGS

In order that the connection between the tubing and hose may be expeditiously and tightly made various types of quick-acting couplings have been placed on the market. Several of these possess merit in a considerable degree, and can be used to great advantage.

One of the most efficient couplings which ever came to the writer's notice was in use in a large shipyard located on one of the Great Lakes. This coupling was somewhat cumbersome and heavy, and these two drawbacks in connection with its expense, seriously militated against its more general introduction, notwithstanding its great merit.

The coupling referred to consisted of two sections, male and female, designed to be screwed together. These sections were placed on the hose and tubing, and expanding nipples were forced into the ends of the latter to a point where the rubber would project about 1/8 in. The distention of the hose and tubing, as a result of forcing the nipples to place, prevented the hose or tubing from drawing out of its respective section. When the coupling was connected up, the ends of the hose and tubing abutted, and when the coupling was tightened the rubber ends spread, and an absolutely perfect seal was effected. In making an examination not even the slightest leak in more than three hundred couplings could be discovered.

AUTOMATIC VALVES

To add to the efficiency of their air system, the branches of the main pipe line were equipped at suitable intervals with what might be termed automatic valves. These valves were so constructed that when the nipple on the end of a hose section was screwed to place the valve was opened, and air permitted a free and untrammeled passage, and when the nipple was unscrewed a short distance or removed entirely the valve automatically closed. This permitted cutting off air to the hose line without detaching the latter, and also prevented leakage through inadvertance in not properly turning down the valve to its seat. The advantages gained by the use of the couplings and connections described amply repaid for any increased cost of installation.

There are a number of very efficient couplings to be had at a small cost. Any of the well-known manufacturers of pneumatic tools is in position to furnish a coupling which will prove entirely satisfactory in use.

DIFFERENT TYPES OF COUPLINGS

It is not the intention of the writer to differentiate between these couplings so far as merit is concerned, but only to briefly refer to their construction, and operation and to present the advantages claimed for them.

One of the most efficient couplings has had a wide and extended sale, and seems to meet all requirements. These couplings are interchangeable one with the other in sizes from ¼ in to ¾ in., inclusive, while sizes 1 in. and 1¼ in. interchange. These couplings are almost instantly connected and should be air-tight under all reasonable pressures.

Another coupling is extremely ingenious in its construction, and is universal in all respects, neither half is male or female, but a combination of both, which permits a ¼-in. hose to be coupled to a 1-in. pipe, and ½-in. hose to 1-in. hose. In other words any size will couple to any other size whether it be larger or smaller. The gaskets are so placed in the two halves of the coupling that it is impossible for them to drop or be blown out when disconnected.

There is also another coupling like the two couplings previously mentioned which is adapted for universal use, that is hose of ¾ in. diameter may be connected with hose up to 1 in. diameter, and this without any reducing. It only requires a third turn of the hose to effect a union. Like other couplings, leaky joints are hardly possible.

The couplings referred to are all light in weight, and offer no detrimental obstructions, in fact this feature is one that has been worked out so far as could be with good results.

Another very essential point in the conservation of compressed air, is that where the nipple enters the hose or tubing, great care should be exercised to see that the nipple is tightly secured in place. It proves expensive, if a riveting gang of three men is stopped at their work while a nipple which has blown out is being replaced, and especially so if the blowing out occurs at the time a rivet is only partially driven. The nipple should have a grooved, or cut, face in order that the hose may sink into these grooves, or cuts, and thus be firmly held by the wire band or clamp, whichever may be employed.

If attention is given to the saving of air through maintaining tight connections at all points, the compressor capacity is relatively increased, and the coal bill is proportionately diminished.—*American Machinist.*

Even small economies are not to be overlooked in these times. The cost of writing ink has advanced more than 100 per cent., while very satisfactory ink can be made from discarded copying type writer ribbons. Instructions for the making, as given out by the M. K. & T. Ry., are as follows: Fill a quart bottle with water and allow the ribbon to soak twenty-four hours until the coloring matter has been dissolved. The result will be a good grade of writing ink—as good as can be purchased on the market. It may be used in fountain pens.

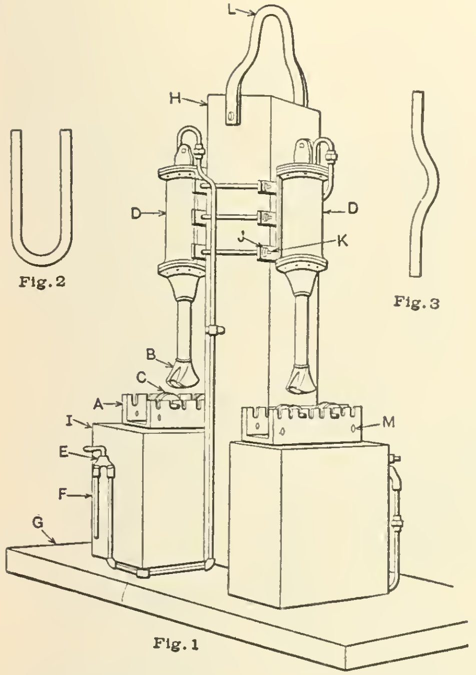


Fig. 2

Fig. 3

Fig. 1

PORTABLE AIR OPERATED TUBE BENDER

Having various sizes of tubing to bend and set up in different parts of the factory, it was decided to make, at small cost, a machine that could be brought close to the job being set up, and thus save the time spent in going to the machine to make the bend and then back to the work to try the tube in place. Most of the work was special and required more or less cutting and trying so as to make a good job. The machine designed is shown in the accompanying illustration. It was made in tandem so as to enable two men to work simultaneously or so that each side could be set for a different bend, thereby elminating the necessity of changing the positions of the rolls. One of the air cylinders *D* is twelve inches by twelve inches and the other is eight inches by twelve inches, as these were on hand.

The roll-holder *A* has several slots on each side, cut opposite each other, to hold the shaft that contains the rolls; these slots are spaced so as to obtain the necessary bends. The holes *M* are used for hold-down bolts (not shown) when bending pipe as shown in Fig. 3. The former *B* and the rolls *C* are made to suit the diameter of tube and the radii of bend. The control of the cylinders *D* is obtained by the air valve *E*, which is connected to the main line by a flexible shaft *F*. The frame of this machine, consisting of the base *G* and the uprights *H* and *I*, was made of heavy pine logs bolted together. The cylinders *D* are bolted to three steel straps, which are held to the column by six heavy bolts *J* and *K*. The bail *L* is for the crane hook. Figs 2 and 3 show two of the bends that are made; right-angle bends can be made, if desired, by strapping down one end of the tube. Miscellaneous straps and bolts are used in connection with the bending, but are not shown.—*G. E. P. in Machinery.*

EMPLOYMENT OF DIVERS IN SHAFT SINKING*

H. GRAHN.

Of late years the employment of divers in shaft sinking has proved very useful for a number of purposes, in the Bochum district, including the fitting and removal of pump strainers, the examination and freeing of sinking shoes, overhauling shaft pumps, replacing cables disturbed by the influx of water, etc.

At one pit in the Witten district, when the shaft had been carried down to about 25 yds., a feeder discharging some 250 gals. of water per minute was tapped at about 125 yds. by a 12 in. borehole in the shaft bottom, this hole being kept open by a wire rope which could be raised or lowered from bank or from the shaft bottom. The casing inserted in the borehole in its upper portion, which passed through loose rock, was closed by a fluted, taper wooden plug, a certain amount of the water being allowed to escape through the grooves in the plug and perforations near the top of the casing. When the lower portion of the shaft was being lined with concrete, a pile of rough stones was made round the projecting end of the casing; and, to facilitate the setting of the concrete and maintain a counter pressure in the interior of the shaft, the water was allowed to rise nearly to the level of the staging. Owing to some of the concrete having run down into the pile of stones, the wooden plug was found to have jammed, and could not be pulled out; and the

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*Colliery Guardian, Translation from *Gluckauf.*

water rose to within about 16 ft. of the bank, the shaft being completely flooded.

A diver was sent down for several days to recover the skips and other articles on the shaft bottom, and more particularly to break up the cemented stone pile round the casing, so as to free the plug and the mouth of the borehole. The plug being nearly 5 ft. long, and extendnig for over 3 ft. into the casing, it was decided to bore it out. To provide proper guidance for the boring bar, 65 ft. in length, a 2½ in. pipe was let down, the lower edge being provided with sharp teeth so as to get a good grip into the top of the plug, the diver holding it in position until the boring tool was deep enough into the plug. Through the 1½ in. hole thus formed, the water was allowed to run for several days, at the end of which time, however, another stoppage of the borehole occurred and necessitated the aid of the diver in boring through the plug again. The borehole was then flushed out thoroughly, and a rod, composed of railway rails, lashed together, was lowered into it and suspended from an iron girder on the shaft bottom, so that, as sinking progressed, the girder and rod descended automatically by their own weight and prevented the hole from choking up again. This done, sinking was continued without any further water troubles.

During the difficult operation of unwatering the State colliery at Waltrop, divers were frequently employed. At first an attempt was made to cope with the extensive inrush of water—amounting to nearly 4,000 gals. per minute—by means of Tomson water barrels. In carrying out this plan, much trouble was experienced with the flat winding ropes used, these being severely strained by the great weight of the ropes themselves and the full barrels, and jamming in the winding bobbins. Moreover, when little progress could be made in lowering the water level, the repeated splashings of the saline mine water every time a water barrel was lowered acted on the pitch-pine guides and softened the timber, which then easily broke. This entailed repairing the guides under water, the divers having to work at a depth of about 70 ft. Eventually, however, the work of unwatering with barrels had to be given up, owing to the above-mentioned rope troubles, and carried out by means of mammoth pumps, arranged in series.

Considerable practical importance attached to the work done by divers in sinking two shafts by the cementation process, one of them being driven through the fissured white marl of the Recklinghausen district. When this shaft had got down to a little over 500 yds., and was only some 150 yds. from the coal measures, one of the advanced boreholes struck the powerful feeder. As there was no stuffing box on the standpipe of the borehole casing, and as the rods, forced up by the rush of water, jammed against the staging near the shaft bottom, it was impossible to cap the pipe, and the shaft soon became flooded to a depth of about 45 yds. The diver sent down to investigate reported that the force of water issuing from the pipe was too great to allow the latter to be capped; and it was therefore decided to rearrange the unwatering appliances in order to obtain a much greater output than before. Within a few weeks the water level was lowered to about 30 ft. above the shaft bottom, this head being left to oppose the stream from the borehole and facilitate the work of the diver.

To plug the standpipe, the arrangement shown in Figs. 1 and 2 was designed, consisting of a tap *a* into which was screwed a tube *b*, tapering at its lower end and provided with threads *c*, intended to cut a thread in the standpipe. The conical portion was continued to a point by means of three pieces of T-section (section A—B, fig. 2). A pipe *d* was secured to the upper end of the tap, to serve as a guide for the winged strap *e*, in which it could move freely until the strap made contact with a fixed collar on the pipe.

The strap *e* was connected to the top of the standpipe by means of 1 in. screw bolts *g* pivoting on a strap mounted on the standpipe, the bolts being long enough (Fig. 2) to allow the tap to be swung. The parts were assembled at bank and taken down by the diver, who, after placing the device in the position shown in Fig. 1, tightened up the strap *f* on the standpipe and swung the tap through an angle of 90 degs., thus bringing the point of the apparatus into the mouth of the standpipe and centering the pipe *b*. On then rotating the whole tap, the taper thread cut its way into the standpipe. To prevent the tap being forced out bodily—the water issuing at the rate of nearly 700 gals. per minute, and under a pressure of about 30 atmospheres—the nuts on the rods *g* were tightened up so as to brace

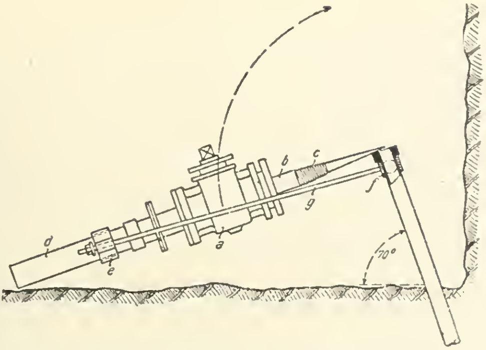

Fig. 1.—Tap and Plug ready for Swinging.

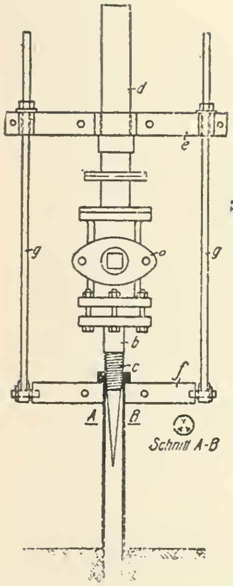

Fig. 2.—Tap Screwed into Standpipe and Secured.

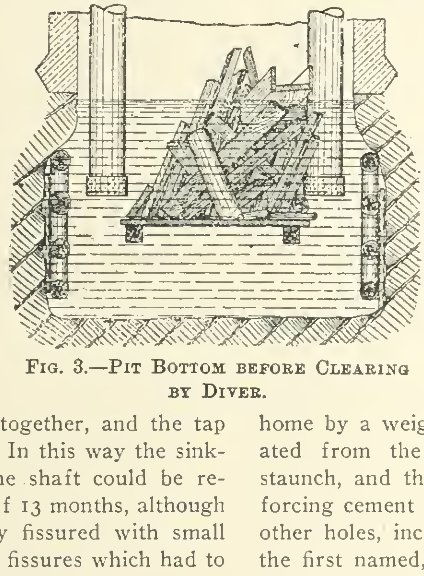

Fig. 3.—Pit Bottom before Clearing by Diver.

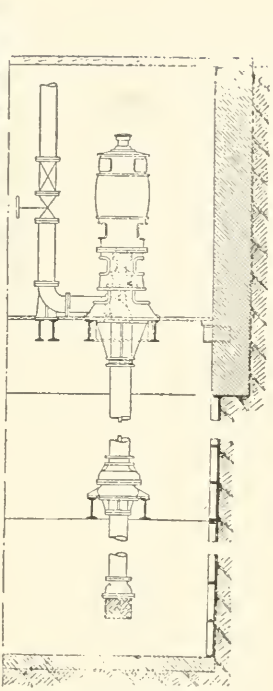

Fig. 4.—Submerged Electric Pump, with Shaft Mounted in Standpipe.

the two straps *e* and *f* together, and the tap was then shut (Fig. 2). In this way the sinking and cementing of the shaft could be resumed, after a stoppage of 13 months, although the rock was extensively fissured with small feeders and several large fissures which had to be stopped with many tons of cement.

A similar case arose in sinking a shaft at the Asse potash mine, through bunter sandstone, by the cementation process. On striking a big feeder, the tap of the standpipe was turned off, but water escaped through a split in the pipe and flooded the shaft. When the pumps had lowered the water to within about 50 ft. of the shaft bottom, a diver was sent down to remove the tap and plug the pipe. The first attempt at plugging, with a couple of steel tubes and rubber washers, failed because the water forced the device out of the pipe, in spite of the free passage left by the tubes. Better results, however, were obtained by the use of a wedge-shaped plug of soft wood, which the diver inserted into the standpipe by the aid of a steel pin 10 in. long, stuck in the point of the wedge, the latter then being driven home by a weight attached to the rope, operated from the surface. This plug proved staunch, and the shaft was pumped dry. By forcing cement down the other standpipes, the other holes, including the one substituted for the first named, were plugged as soon as the feeder was reached in boring; and the sinking progressed to completion without further trouble.

In sinking a shaft, on the left bank of the Rhine, through tertiary rock, with an iron sinking shaft and Priestman grab, the rope broke at about 30 yds., leaving the grab on the bottom. As the grab excavated mainly at the centre, so as to allow the sides to cave and furnish loose soil, the diver sent down had some trouble in locating the grab, and clearing away round it so as to allow a strong cable to be attached. The work was rendered particularly arduous on account of low visibility, the water being laden with fine tertiary sand and loam, and quite opaque at the shaft bottom. Almost similar work had recently to be performed in an iron sinking shaft in a mine in Upper Silesia, the sunken grab having first to be dredged clear in between 80 and 90 ft. of water. A heavy cable was attached to the grab, and was lifted by means of a steam winch and pulley tackle alternately, the strain pulling a 2½ in. wrought iron hook (about 3 ft. long) out straight. Eventually the grab was recovered by exerting a gradual pull on the rope.

In sinking the Adolf shaft of the Eschweiler Company, it was found impossible to force the sinking shoe down below about 20 ft. above the coal measures, even after boring out the shaft completely; and on this account a concrete plug was prepared on the shaft bottom and then bored through. In the course of this work several leaks were made, and a diver had to be sent down to locate them, and plug them with concrete. The expectation that the insertion of a couple of connecting rings would enable the sinking to be carried down to the coal measures without further trouble was not realized, a further leak in the concrete plug necessitating the flooding of the shaft to prevent the caving of the rock. The diver widened the breach to a width of 7 ft., height 1 ft., and depth 20 in., packed sandbags in front of the opening, and quickly kneaded in the cement, poured in with buckets. In a few days the cement had set hard enough to allow the shaft to be unwatered, and sinking continued to completion.

In putting down a new shaft at the Dutch State Colliery, Emma, the upcast pipe of the shaft pump broke, a length of over 200 yards of pipe falling down the shaft, and burying itself and the sinking pumps in the shaft bottom. A diver was sent down for several days in succession to ascertain the best places for progressively lowering the new sinking pumps, and eventually the shaft was cleared. Another instance of the utility of divers' work was afforded in a pit at Herne, Westphalia, where a shaft was being unwatered by means of water barrels, which operation was retarded by a bar connecting the on-setting device at the pit eye. This bar had to be partly unbolted and partly cut through by the diver, who also repaired and renewed the guides, and set up wire netting, 10 ft. in height, on both sides of the pit eye to prevent the water from floating anything down from the roads into the shaft.

In putting in a new winding rope at the De Wendel pit, the old rope, which was attached to the new one, broke and dragged the latter down the shaft, and at the same time completely destroying the tail rope. The whole of them fell into sump and stopped the pump at work there and the diver was engaged for nearly three weeks in clearing up the damage. Again, while the No. 11 shaft at the Ewald-Fortsetzung pit was in course of sinking, a sudden rush of water flooded the pump motor, and it was decided to install a centrifugal pump to work in 30 ft. of water so that no suction would be required even if the water level were lowered, the motor being mounted just below bank in order to guard against flooding in the future. With this object a diver was sent down to put up a pair of 10½ in iron girders across the 18 ft. shaft and bolt them to the flanges of the tubbing (Fig. 4). Two iron plates to carry the pump were secured to the girders, the suction pipe of the pump being led up between them. The vertical shaft of the pump was led up about 65 ft., inside the upcast pipe and guided by wooden bearings mounted between the pipe flanges. The upcast pipe was bent horizontally just below the motor, and was provided at the bend with a stuffing-box for the passage of the pump shaft. The pump was constructed to raise 660-gals. per minute against a head of 190 ft.

In the foregoing operations, wherever compressed air was available, the supply of air to the diver was taken direct from the air mains, thus dispensing with the troublesome work of pumping air. In several cases, mine officials who had studied diving operations during their mining-school course, rendered effective assistance to the diver; and it is therefore recommended that, in the case of pits where water troubles are frequent, some of the officials, overmen in particular, should occasionally practise working in diver's dress (on the same lines as the members of rescue corps exercise with breathing appliances) at some mining school where such instruction is given.

FOR THE PNEUMATIC COMPACTING OF CONCRETE

Reinforced concrete for building walls is commonly mixed quite wet and is usually compacted, by spading it. Concrete containing less water, and of a quaky rather than fluid consistency, is sometimes specified; but it can not be economically tamped in thin reinforced walls. However, it can be compacted by striking the forms and the reinforcing bars with a light wooden maul. This suggests the possibility of using a pneumatic hammer for this purpose, for a large number of sharp, light raps should prove effective in causing the concrete to settle tightly in the forms.—*Engineering and Contracting.*

THE GLOBE-JOHNSON ROTARY AIR PUMP

Reciprocating air pumps when employed for the production of high vacua have their well known disadvantages and shortcomings, some, if not all, of which are avoided in the Globe-Johnston rotary valveless air pump here presented. It is offered to the public by the Globe Pneumatic Engineering Co., Ltd., 1 Victoria St., London, S. W. I.

Fig. 1 is a section of this pump and shows clearly its construction and action. It is applicable to every process where vacuum or low-pressure compressed air is required.

The minimum capacity for which the smallest size is built is about 20 cu. ft. per min., and the various sizes are graded upward so that the largest machines cover the highest capacities used in industrial processes. The speed of rotation ranges from about 3,000 r.p.m. for the smallest sizes down to about 1000 r.p.m. for the largest. The pump can operate with any type of condensing apparatus, and in connection with these plants will produce under favorable conditions a vacuum within one-half inch of the barometric reading.

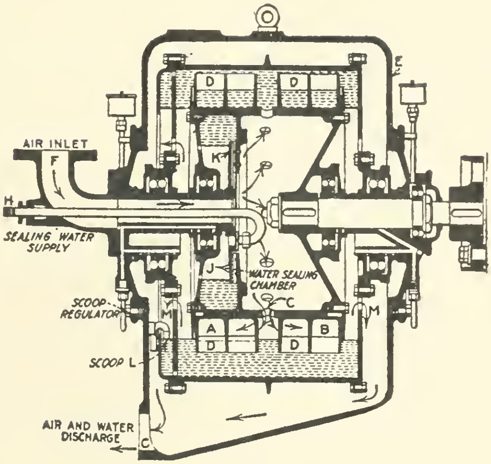

FIG. 1

As an air and gas compressor or blower, the machine is applicable to all processes where low-pressure air is required.

According to the *Steamship,* this rotary vacuum pump and compressor consists of two main parts, the rotor and the drum. These parts rotate on ball-bearings. The modification necessary to convert the vacuum pump into an air compressor is slight, but a reversal of certain component parts or of the direction of rotation is necessary. The difference in arrangement between vacuum pump and compressor will be seen on reference to Figs. 2 and 3. Its construction is shown in the accompanying illustrations.

The rotor, shown in Figs. 2 and 3, is a hollow member on the outer circumference of which deep double-thread screws are formed.

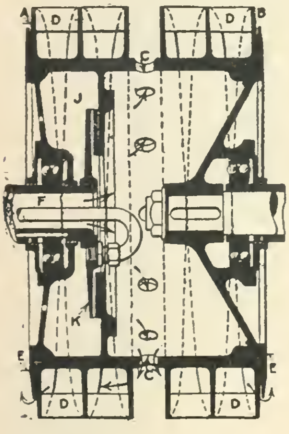

FIG. 2

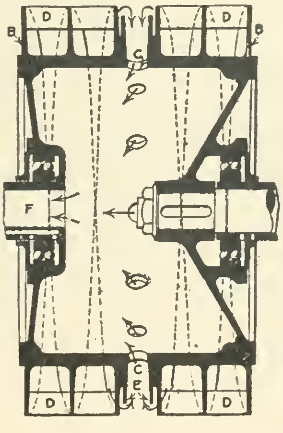

FIG. 3

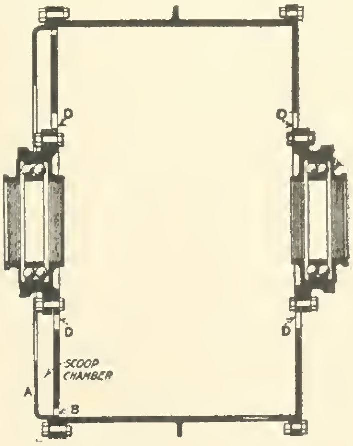

FIG. 4

Fig. 2 shows the arrangement of the rotor for the vacuum pump and Fig. 3 for the compressor. In the smaller machine these threads are single-handed only, but in the larger sizes right and left double threads are employed in order to obviate the possibility of end thrust. A passage C runs between the twin-screw threads *A* and *B* into the interior of the rotor. When the machine is producing a vacuum, this passage acts as the inlet to the screw threads, but when air is being compressed it is the outlet. Similarly, the pipe *F*, running from the interior of the rotor to the exterior of the machine, is the inlet pipe in the vacuum pump and the outlet pipe in the compressor. The screw threads are joined by a large number of narrow partitions, or blades, *D* which are equally spaced round the periphery of the rotor. The outer and inner edges of these blades are respectively flush with the top of the screw threads and halfway down the depth of the threads, Figs. 2 and 3.

The ring of water is, in the first place, set up by the action of these blades in conjunction with centrifugal force. Annular rings *E*, called shrouding plates, fitted to the sides of the rotor and reaching somewhat below the water level on the discharge side, prevent the exhausted or compressed air returning along the screws when the thread ends leave the water seal. The motor is coupled direct to the driving shaft.

The rotating drum, Fig. 4, is a hollow cylinder also running on ball bearings. The holes *D* in the side plates of the drum act as discharge and inlet openings for vacuum pump and compressor respectively. The drum, when rotating, contains the "ring of water" and is set eccentrically to the rotor. The relative eccentricity of the rotor and the water ring produces what is called the working space, as shown in Fig. 5. The net circular area of this space considered in conjunction with the pitch of the screw threads and the speed of rotation is the measure of the air capacity of the pump.

At one end of the drum a ring *A*, Fig. 4, is fitted, forming a channel communicating with the drum through the holes *B*. The scoop, the function of which is described later on, is a suitably formed piece of tubing fixed into the wall of the casing, having its working end dipping into the previously described channel and pointing in a direction opposite to that of the rotation of the drum. It is shown at *L*, Fig. 1. In vacuum pumps where the load is practically constant very little adjustment of this scoop is required, but means are provided for changing its position by hand. In air compressors this adjustment can be made automatic, and an effective means of adapting the output of air to varying demands is thus provided. As the demand is reduced and the pressure, in the receiver or pipe system tends to rise, the automatic control gear causes the scoop to lower the depth of the ring of water until compression ceases. In these circumstances the power consumption is reduced to about 15 per cent. of that required at full load, with a corresponding reduction in the running costs. As the pressure falls the scoop is automatically returned to its working position, whereupon the water rises to the required depth and compression begins again.

The casing *E*, Fig. 1, is a cast-iron or steel structure with the upper cover removable to facilitate examination or the dismantling of the machine. The rotor and drum rotate on ball bearings in this casing. The aperture *F* is the induction pipe, and the opening *G* the air and water discharge pipe in a vacuum pump. The casing and rotating parts form a self-contained unit which may be mounted on a bedplate, brackets, concrete or any other suitable foundation.

The essential feature of the pump is a rotating screw, set eccentric to and working in conjunction with a ring of water established and maintained by centrifugal force within a container called, in the following description, the "Drum." To put the machine into operation water is allowed to flow through the pipe *H*, Fig. 1, and the pump is set in motion. The water passes through the water-sealing chamber *J*, to the interior of the drum, which it gradually fills until it becomes deep enough to be caught by the partition blades *D* of the revolving screw rotors *A* and *B*. It is then whirled round the interior of the rotating drum *C* by these blades.

The friction between the whirling water and the drum causes the latter to revolve also, and in a very short time the drum and the rotor are running at practically the same speed. The sealing water continues to flow into the machine until a ring of water is formed within the drum sufficiently deep to submerge the screw threads on the rotor at the point where,

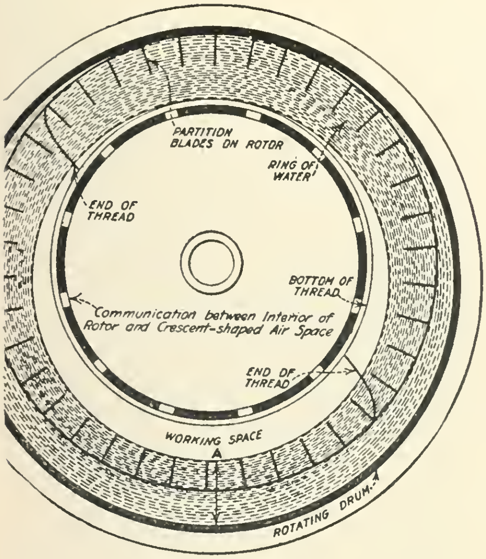
PARTITION BLADES ON ROTOR
RING OF WATER
END OF THREAD
BOTTOM OF THREAD
Communication between Interior of Rotor and Crescent-shaped Air Space
END OF THREAD
WORKING SPACE
A
ROTATING DRUM

FIG. 5

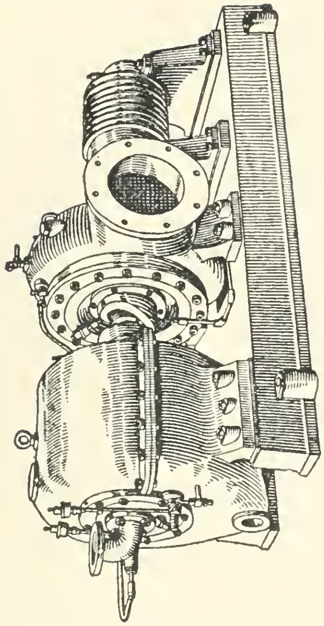

FIG. 6

owing to the eccentricity, they approach nearest to the inner periphery of the drum. It is this water, maintained in the form of a ring within the drum by centrifugal force operating in connection with the threaded rotor set eccentric to it, that produces the pumping effect. Immediately the ring of water has reached the proper depth, the pumping action begins. The position of the ring of water in relation to the rest of the rotating system is shown in Fig. 5. The friction referred to obviously ceases when the two parts have acquired the same speed.

The time occupied between the first revolution and the moment when pumping begins varies according to the size of the machine. With machines of the largest capacity it is only a matter of a few minutes.

During the operation of the pump a small stream of water flows continuously into the drum through the pipe *H*, Fig. 1, and in order to maintain the correct depth in the ring of water, a scoop L is fitted. The scoop skims off the surplus water, and this function is continuous while the pump is working. The water may be conducted from the scoop back to the supply tank and be used over and over after being cooled.

The water seal is merely a substitute for stuffing-box. It consists of a fixed disk *K*, Fig. 1, around which a chamber containing water rotates. An equal water level on each side of the disk is maintained by the centrifugal force in the water. If, however, atmospheric or other pressures exists on one side of the disk and not on the other, it is obvious that this level will be disturbed and the water will rise higher on the side opposite to that on which the pressure is exerted. A new point of balance will thus be found wherein the combined pressure and centrifugal effect on the one side will be equal to the centrifugal effect alone on the other. If at this point the periphery of the disk is sufficiently submerged, it is clear that no leakage of air can take place from one side to the other. Being so arranged as to receive automatically a continuous supply of water, the water seal requires no attention to keep it tight.

EXTINGUISHING FIRES OF GASOLINE OR OTHER LIQUIDS*

BY GEORGE A. BURRELL

There are two principal methods of extinguishing burning liquids, as follows

1. To form a blanket of gas or solid material over the burning liquid and cut off the air-supply.

2. To dilute the burning liquid with a non-

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*From Technical Paper No. 127, U. S. Bureau of Mines.

inflammable extinguishing agent that will mix with it.

Water may be used for extinguishing burning liquids, such as denatured alcohol, wood alcohol, and acetone, that are miscible with it. If such a liquid as gasoline, which is not miscible with water, catches fire, the application of water produces little or no effect except to spread the burning liquid, and thus scatter the fire over a larger area. However, the application of a large quantity of water to a small quantity of burning oil, by its cooling effect, may aid in extinguishing the fire.

Of materials used to form a blanket of gas or solid material over burning liquid, thus cutting off the oxygen supply, several are in common use. These include sawdust, sand, carbon tetrachloride, and the so-called foam or frothy mixtures.

The efficiency of sawdust is due to its floating for a time on the liquid and excluding the oxygen of the air. Sawdust itself is not easily ignitible, and when it does ignite burns without flame. The character of sawdust and its moisture content is of little or no importance. For extinguishing small fires, when just started, it may be applied by means of long-handled wooden shovels.

Sand probably serves about as well as sawdust for extinguishing fires on the ground, but is heavier and more awkward to handle. When thrown on a burning tank it sinks, whereas sawdust floats.

Carbon tetrachloride, the basis of various chemical fire-extinguishers, if thrown on a fire forms a heavy non-inflammable vapor over the liquid, and mixes readily with oils, waxes, japan, etc. The vapor is about five times as heavy as air. When thrown on a fire, it produces black smoke, the hue of which is caused by unconsumed particles of carbon. Pungent gases are also produced, probably hydrochloric acid gas and small volumes of chlorine gas. Although the fumes are pungent, brief exposure to them does not cause permanent injury.

The efficacy of carbon tetrachloride depends largely on the skill of the user. If liquid in a tank is on fire, the height of the liquids is important. When the liquid is low, the sides of the tank form a wall which retains the vapor, but when a tank is nearly full of a highly volatile liquid like gasoline, only the most skilled operator can extinguish the fire.

For smothering some small fires of burning gasoline an ordinary blanket may be used.

Methods depending on the use of foam or frothy-liquid mixtures to extinguish fires in large gasoline storage tanks originated in Germany. For such an extinguisher two liquids are caused to mix in a tank, whereupon foam is produced. The tank is made airtight and sufficiently strong to permit the foam to be forced out under pressure of a gas (carbon dioxide) simultaneously generated. The frothy mixture owes its efficacy to its blanketing action in excluding air from the fire. It is stiff and shrinks only slightly in volume even after half an hour. In one installation, water, bicarbonate of soda, and soap-bark are used in one tank, and acid in another tank. A fusible link, which will melt at 212°F., releases a hammer, which breaks the glass tank containing the acid. The released acid is led through two perforated pipes into the solution, producing a violent ebullition of foam, which finds its way into the tank of burning oil.

COOLING, DRYING AND PURIFYING AIR*

BY W. J. BALDWIN

The necessity for removing dust and other impurities from the air needs no amplifictaion from me, as we all recognize the advantages of pure air and nearly all strive in every way to obtain it.

WHAT IS PURE AIR?

The ordinary meaning of the term pure air, however, should be amplified, and when it appears in a contract it should mean more than that the air should not be fouled by the human breath and by exhalations from the human body. The engineer must not be content when making an examination within an enclosed structure simply to report that the air is maintained at some common standard of purity of contamination, expressed by the number of times the CO_2 within the room is in excess of the standard, good or bad, found to exist outside the enclosure. Such a standard gives only an approximate idea of the condition of the air within the enclosed space, and it is the roughest approximation under the common acceptance of the term.

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*American Society of Mechanical Engineers, New York meeting, Dec., 1917.

Presumably there is no pure air near the surface of the ground, nor in the atmosphere of cities. The best we have exists at the tops of mountains, or on the ocean, but even this we are unable to standardize.

Air with about two parts of CO_2 in 10,000 is considered good, no matter where we find it; but in cities where much coal is burned the proportion is higher, and may rise to as high as 10 parts of CO_2 in 10,000. An increase from 2 to 4 parts in 10,000 for enclosed spaces above the outside conditions has been considered good, even for schools and hospitals, and very good for workshops.

DRYING AIR

These conditions, however, do not comprise the whole problem. Further effort should be directed toward drying air by some simple mechanical process. In attempting to free air from an excess of humidity, which is often as much of an impurity as are the other forms of contamination, I have the following data to offer:

About two years ago I worked to perfect an apparatus that could be put in the porthole or the dead light of a ship and would exclude the rain or spray, while freely admitting large quantities of air to the cabin of the ship, without admitting the water. This led to freeing the air of an excess of humidity.

The experiments conducted with the preliminary apparatus for excluding rain or spray while freely admitting the air as in the case of a ship rolling heavily at sea, suggested the possibility of removing the excess of humidity in the air, particularly with a view to admitting air to the radio room of a ship, and not only exclude the rain and the spray but also regulating the humidity, so as to keep the air at *some common standard of saturation* as far as humidity was concerned. The purpose was to overcome a difficulty with the attuning apparatus of the receiving and sending instruments, either at sea or in the higher atmosphere.

This led to the design of an apparatus for a radio room on the lines already set forth, that would admit air not only separated from rain, salt spray and spume, but that would also condition or regulate the humidity within the room by keeping it at a common standard of humidity, regardless of the outside changes.

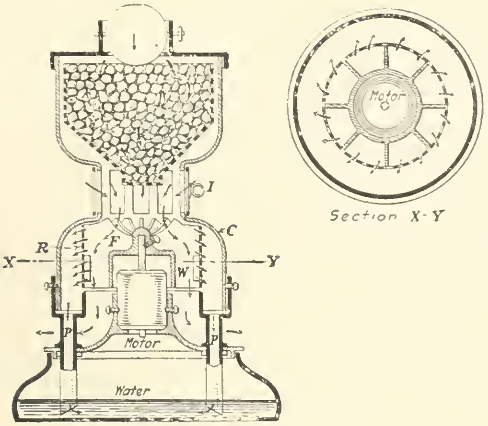


FIG. I

Cold water in the spray form will do this provided the spray can be gotten rid of after it has combined with the excess of humidity (steam in the air) and then separated from the air by some practicable form of apparatus that is simple, and that occupies small space.

While a shower of rain will clear the atmosphere, the elements of nature have all outdoors in which to set up the apparatus for such a result. The cabin of a ship or a radio cabinet is infinitely small in comparison with all outdoors, yet a similar result can be achieved in a space as small as a cabin or radio cabinet.

To accomplish this I used a cold-water spray apparatus similar to one I had designed two years earlier for the purpose of precipitating the CO_2 when found in great excess in a confined space, as in the hold of a submarine, when forced to stay a long time under water.

In this machine a spray of potash water was used in connection with a mechanical dust precipitator for the purpose of seizing on the carbonic acid in the air and throwing it down so as to eliminate the CO_2 at the dust and water discharge of the apparatus.

It was proposed to put the apparatus in a bulkhead; the discharge side of the apparatus coming into the air of the living quarters, the air freed of its CO_2 being forced backward again into the chamber of greatest vitiation, thus forming a cycle.

In the general experiments it was found that a prepared spray of chemical liquid or even cold water not only seized on the dust but on other gases in the air, with which the chemical in the spray would combine, and that a

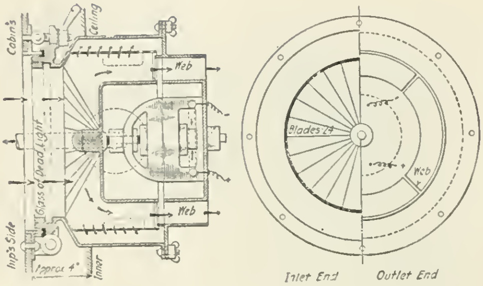


FIG. 2

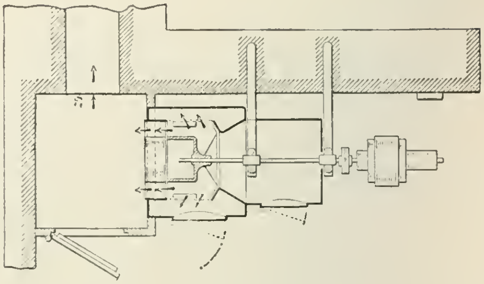


FIG. 3

pure-water spray turned into the apparatus would keep the humidity of the air constant by suitable regulation of the temperature of the water spray. In a room at 90 deg. fahr. and a humidity of almost 90 per cent. we could drop the humidity to 45 per cent. by reducing the temperature of the spray to 70 deg. fahr.

A simple form of the apparatus arranged for cooling a room is shown in Fig. 1. The apparatus from the inlet to the line *X-Y* is an ordinary fan or blower *F*, and the downward extensions of the fan blades or wings *W* are necessary to accelerate the rotary motion of the air.

The rotor *R* is a rotating hoop of permeable metal, against the inner side of which the air is thrown with all its impurities. If the heavy particles in the air, such as dust, mud or particles of water, strike into the perforations of the hoop, they pass through into a quiet space formed by the outer case *C*, Or, if they strike on the solid part of the hoop, they are rubbed through the nearest holes by the forward movement of the air. They then pass into the quiet space *C*, drop down within it, and escape by the pipe or pipes *P* into the tank.

The air does not escape with the heavy particles, as might appear at first, for the lower ends of the pipe legs are sealed by the water in the tank. The tank may be of any shape, or there may be no tank, the separated particles going to a waste pipe.

The greater the velocity of the rotor *R* the more efficient is the apparatus. A speed of 5,000 ft. per min. is very practicable, but 10,000 is not excessive, either from the point of bursting or for any other reason.

The fan gives the same static pressure as any other centrifugal blower of equal diameter and speed and requires only equal power for equal work, and the power required for separation and friction is considerably under 25 per cent. of the blower power required to move the air.

The device as described above illustrates the principle of the various types of apparatus, whether used for taking the dust from the air, the CO_2 from a chimney or an enclosed space, the excess of humidity from the air, throwing down fog, cooling and moving air, etc. It will be noted that the ice in the upper tank serves both as a cooling medium and for the supply of cold water, broken into spray by the rapid motion of the fan, for the purification of the air.

In Fig. 2 is shown a type of the apparatus as developed for use in the porthole of a ship, and in Fig. 3 a horizontal design for the removal of dust particles from the gases of combustion in a chimney.

MEASURING AIR DELIVERY OF TURBO BLOWER

BY THOMAS G. ESTEP, JR.

When the reciprocating type of compressor is used for furnishing air for blast furnaces, no devices are absolutely necessary for measuring the volume of air delivered. All that is necessary in order to obtain a close approximation of the quantity of air is the displacement of the compressor and the volumetric efficiency. The latter factor is an uncertain one, depending upon the clearance of the compressor, the ratio of compression to supply pressure and the leakage through valves and around the piston. The volumetric efficiency can, however, be estimated very closely and the volume of air delivered by the compressor can be determined accurately enough for all practical purposes. Even if any of the various measuring devices were used in connection with reciprocating compressors, the results would be in error, due to the pulsations in the flow.

The advent of the turbo blower for furnishing air for blast furnaces has presented a new problem to engineers. It is very essential that the volume of air delivered to the furnace be known at all times and it is even desirable that a continuous record of this quantity be obtained so that a comparative study of the furnace operation can be made.

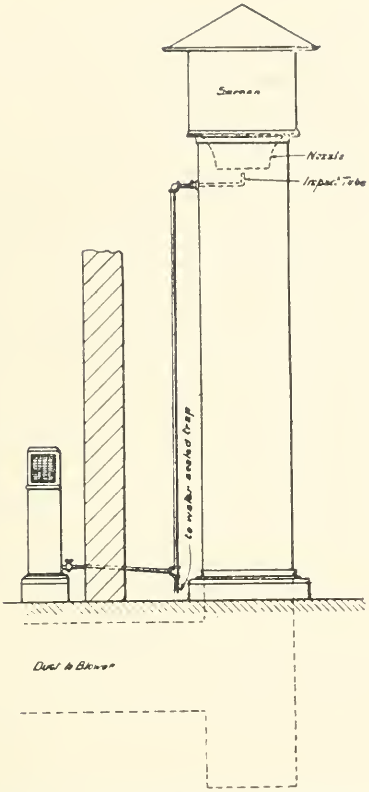
The blower itself does not give any means of making this determination as does the displacement compressor so that some other means must be employed. Due to the fact that the turbo blower produces a steady flow, any of the approved methods of measuring gases can be used, the only question being to select the most suitable, accuracy and simplicity being the predominating features.

A pitot tube placed in the intake pipe would at once suggest itself as being a simple and accurate means of measuring the volume of air, and such installations have been made which are giving uniformly satisfactory results. There are, however, certain factors which must be taken into consideration before such an installation will give reasonably accurate results.

The intake pipe is usually made up of riveted steel plates of which the internal diameter may not be uniform. The ring seams may cause eddy currents which would influence the flow, and in certain cases the intake pipe may be so short that the flow does not become uniform before being measured.

If the intake pipe is long enough and the diameter accurately determined at the point of insertion of the pitot tube, and then a traverse of the pipe is made so that the tube can be placed at a point which will indicate average velocity, the quantity of air flowing will be determined accurately enough for all practical purposes.

The most satisfactory installation seems to be a combiantion of a standard orifice and a pitot tube. The standard orifice can be placed in the end of the intake pipe, directly under the hood and the pitot tube used to measure the velocity of the air leaving the orifice. Aside from the great accuracy of such an installation, which is of first importance, it has the following advantages:



Showing arrangement of air intake, nozzle impact tube and recording instrument.

Practically no changes are required in the intake pipe. The hood may have to be raised a little in order to install the screen and to give a free inlet to the orifice. Some tests made at the laboratories of the Carnegie Institute of Technology showed that if the hood was at least one-fourth the diameter of the pipe away from the orifice it would have no influence on the flow.

The orifice being located in the end of the pipe, the velocity of approach is zero, which means that the chart of the recording mechanism is more easily constructed. If the orifice were placed somewhere in the pipe, it would be necessary to take into consideration the velocity of approach which is an added complication to the calculation of the quantity flowing.

With the orifice located in the end of the pipe, static pressure determinations are not necessary, so that the pitot tube in reality becomes a simple impact tube with just one connection to the recording device. This eliminates entirely the much-discussed question of how to measure static pressure correctly.

The length of the intake pipe has no influence on the measurements.

If the orifice diameter bears the proper relation to the pipe diameter, the loss in pressure is negligible. The orifice itself converts a certain amount of pressure into velocity and then, as the fluid issues from the orifice, a transformation from velocity to pressure begins, but due to eddy currents which are produced, not all of the velocity is converted into pressure again.

It is impossible to derive a correct mathematical formula for this loss, but a great many years ago, Carnot proposed an equation for this loss which checks very closely with experimental data. The formula is as follows:

$$\text{Lost head} = \frac{(V_2 - V_1)^2}{2g}$$

Where V_1 = velocity of fluid in pipe, feet per second.
V_2 = velocity of fluid in orifice, feet second.
g = acceleration due to gravity, feet per second.

The lost head is in feet of the fluid being measured.

Tests were made at the laboratories of the Carnegie Institute of Technology which showed that this equation will give fairly close results. When the velocities are low, the calculated loss is too high and when the velocities are high, the equation gives results too low. Over the range of velocities used in the tests, the variation of the actual and calculated loss did not exceed 7 per cent.

If an orifice diameter of about six-tenths of the pipe diameter is used and the lost head reduced to actual additional horsepower required to drive the turbo-blower, we find that it amounts to less than one-half of one per cent., which is certainly allowable.

Several installations of this kind have been made by the Bacharach Industrial Instrument Company, of Pittsburgh, and are giving excellent satisfaction.—*Blast Furnace and Steel Plant.*

RALLY THE ENGINEERS*

Rally all the engineers, we've got big work to do.
We've got to push the Kaiser out and all of his damned crew.
We've got to clean up Potsdam before we're really through.
But we'll keep pushing together.

Hurrah! Hurrah! Our fight is over here.
Hurrah! Hurrah! It's up to the engineer.
We've got to get munitions out and keep the ocean clear
And help rid the world of the Kaiser.

We must rouse the country from its woeful lethargy,
Its habit of expecting that to-morrow we may see
The smashing of the German line by armies o'er the sea,
Or leaving Georgie to do it.

CHORUS.

The engineer will put the pep into the workers' ranks.
He'll not stand long for shirking or the other Hun-like pranks.
He'll throw his slide rule far away before condoning cranks
And down profiteering altogether.

CHORUS.

When the call of peace doth come, the engineer must rule.
He knows the fellow at the top and Tony at the stool.
His judgment of humanity he's learned at life's own school
And he'll bring everyone together.

Hurrah! Hurrah! Our fight is over here.
Hurrah! Hurrah! It's up to the engineer.
We've got to get munitions out and keep the ocean clear
And help rid the world of the Kaiser.

The opening of a new railroad to provide an outlet for the product has led to the dynamiting of one of Switzerland's most famous glaciers and the marketing of the ice.

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*Sung at the Annual Meeting of the American Society of Mechanical Engineers, New York, Dec., 1917.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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THE NEW YEAR AND THE WORLD WAR

To-day we turn a leaf of Life's great book.
The story the fresh opened page shall tell,
Is ours to write for distant age to read
And understand; for only day by day
Ken we our task, and little hint have we
Of the completed plan. We only know
Our way lies straight ahead, with upward trend,
But no smooth resting place, and no let up
For slackness or fatigue.

God's will be done;
Determinedly, inspiredly, we speak,
And not supinely or resignedly.
For upon us it's laid that will to do.

Most thankful must we be that we're not cursed
With long foresight; for were we so equipped
How had we faced the horror crowded years
Just left behind, or how, full confident,
Still dare the gruesome shades and dreads unknown
Which frown so close before?

To reassure
And brace us for the struggle grim which waits.
We need but look far back along the years
And note where vict'ry lodged, and where defeat.
It is no losing fight that Man has fought,
Nor are we listed to be worsted now,
And never held we surer vantage ground.

The game of frightfulness is nothing new;
And if so be Man's foes shall do their worst,
'Tis what they've always done, but now, full grown,
With insane hate and fiendish cunning crammed,
They strike a fiercer blow; mayhap their last.
The ways of war have been transformed, its reach
Extended, so that not alone on land
And o'er the widespread seas, but in the sky
And 'neath the wave destruction rages wild,
With unrelenting potency of hate;
And for the time eluding all restraint

It seemes a change has come to all our ways;
The keynote now is contrariety;
Long years of peace have forged new tools of war,
And now through war we seek the means of peace.

When vict'ry comes, as sure it must ere long,
Not easy will it be to say by whom,
Or when or where was blow decisive struck.

We're all enlisted for the war, and we
Have each some thing that we at least can do
To hasten the result. No warlike garb
May be for us, nor may we face the guns
Or thrust the bayonet, or have our hand
In wholesale butchery, or see brave men
In crowds mowed down.

Our fighters must be fed
And clothed, and swiftly moved from place to place,
And kept supplied to prodigally waste
Hell's fires when the decisive moments come;
And they must surely know that they are backed
Unfailingly by love and trust at home.

How tame is it to prate of duty now.

THE ENGINEERS NOW ALL UNITED

We print here in full the address of W. L. Saunders, "Speaker at Large," on Friday evening, Dec. 7, 1917, in the Auditorium of The Engineering Societies Building, New York, at the ceremonies welcoming the American Society of Civil Engineers into the Fraternity and Habitat of the Founder Societies

Permit me, Mr. President, and ladies and gentlemen, to answer the question, Why I am "at large" at this time? The answer is very simple. I am one of the committee which has had the program of this affair in charge. Mr. Dunn is another. He called me one and I called him another, so in the interest of harmony it was decided to parcel the honors and punish the audience.

As we stand on this Scotch preserve, upon which has been reared this splendid menagerie, we naturally think of the great game-keeper, Carnegie,who made it possible. We are also reminded in the variety of the performance to-night of the party of hunters who, standing at the gate of a Scotch game preserve, said to the keeper, "Have you all kinds of animals here,—any deer?" "Hundreds of them," was the reply. "Any rabbits?" Thousands of them." "Any gorillas?" "Well," said the old Scotchman, "they cum, just like yoursel, now and then."

And so on this occasion you have seen the gentle polish, you have heard the soft and never still voice of the electrical engineer; you have heard the gear-like meshing and the turbine wheeze of the mechanical, tempered by the eloquent tones of the miner, who being also reared in things chemical and metallurgical seems to cry out to our new found friends:

O, come where the cyanides silently flow,
And the carbonates droop o'er the oxides below,
Where the voice of potassium is heard on the hill,
And the song of the silicate never is still.

Come, O come,
And batter the drum
Of boilers and amperes and uranium.

Verily this is indeed a rare occasion! You, Mr. Chairman, to-night are not alone the President of this United Engineering Society, but also of the Society of Illuminating Engineers. Many prophets and kings have longed to see the things that we see and did not see them, but are happily laid where they cannot hear the things that you hear to-night. Think of a full fledged member of the American Society of Civil Engineers, that proud old professional peacock, walking in the same alley with a fellow who calls himself a Mining Engineer, but who never could define it! Truly the lion and the lamb now lie down together, but let us take care that we do not repeat the experience of the circus where a lion and a lamb were exhibited in the same cage, an exhibit made possible only by renewing the lamb at frequent intervals.

Let us hope that the union which we celebrate to-night is not merely a physical contact, but that it represents the spirit and purpose of engineers to get together for service, a service not alone in scientific fields, but on the broader plains of civic life.

Let me tell you a true story of recent events at Washington. One of the most important laws which a Congress ever enacted is the draft law. This law wisely created District Boards for the purpose of determining exemptions. This is the Court of Appeals, the court of last resort, except the President. Each State and territory has one or more district boards. Now as this war is not only a clash of armies, but a combat between industries, it seemed plain that there were many men engaged in industrial work who might render greater service at home than in the trenches abroad, so the advisers of the President succeeded in placing an engineer upon the proposed lists of members of each district board in each State in the Union. On these lists were representatives of the farmers, the legal profession, business men and representatives of labor. Here was the true position for the engineer, the man who is responsible for the creation and operation of our industries. The engineer members were selected from the organization of engineers which had been created by the Naval Consulting Board in each State and territory and through which the industrial plants had been surveyed and listed for war service. The President acting in harmony with our system of government, a government by states, sent these lists to the State governors, asking them to revise them and make such changes in the names as each Governor might deem wise. When the lists were returned to the President more than 90 per cent. of the engineers were scratched off to give place to lawyers and others.

It is useless for us to fume and protest at such incidents as this. It serves us right. We are not organized for civic service. We are not organized for any service. Our institutes, societies, and our engineering council suffer too much from professional megalomania. Such organizations as we have are not framed to suit the kind of government which we live under—a federation of states, counties and wards—a democracy.

Let us hope that we begin to-night by placing the corner stone of a structure to be reared on the lines of engineering democracy. Let us get together, not in high places only, not in the branches, but at the roots of the tree; not alone in scientific fields, but as technical men doing work as citizens, reaching into every village and every ward—a "Technical, Civic Federation." Let us organize; for in organization there is the essence of strength, the basis of influence and the opportunity for power.

FOR AVIATION WORK

The belief may be said to be now universal that aviators are to win the world war, or at least to be the most important agency leading to the final decision. The actual operators of the machines, the heroes of the sky, each represent a considerable number of skilled and responsible men working on the ground for the equipment and maintenance of his apparatus, and without all this service he would be paralyzed and useless. The mental and physical equipment of the qualified aviator must be exceptional, and only a small percentage taken from the average of men could ever be successful flyers, but in the work of building, repairing, adjusting and caring for the machines a great variety of special skill is required, and all good workers and mechanicians can be of service for some detail of the work.

For the further extension of the aviation branch of the United States Navy, Secretary Daniels has authohrized the enlistment of 8,000 young men, and in doing so has opened up most attractive opportunities in this new and unusually appealing service. There is an important and immediate need for mechanicians for naval aviation for the ratings of machinists' mates, carpenters' mates, quartermasters, coppersmiths and blacksmiths. These men will not be enlisted for pilot's duties but coming into the service with a general mechanical turn and a liking for the work they will receive a special and unusual training for the building, handling, repairing and overhauling of the navy's air craft. Succeeding in this they will be used as the ground personnel of the flying corps.

The requirements for enrollment will be the same as those for the regular service of the United States Navy. Training for machinists' mates and quartermasters will last about three months. Carpenters' mates will train for approximately six weeks. On completion of training course the provisional landsmen, after examination, will be rated first or second class petty officers on the basis of examination and all around ability. After getting a rating they will be eligible for promotion to the next higher grade if they show fitness and pass the necessary examination. Promotion in the aviation field is unusually fast. The age limit for this enlistment is 21 to 35 years, and each candidate will receive the U. S. Navy physical examination and not that required for flight duties. Men enlisting for aviation duty but failing to qualify will, if recommended by their commanding officers, be assigned to general service.

The following trades are covered by the ratings: Carpenters, wood-workers, machinists, coppersmiths, blacksmiths, fabric workers, riggers, acetyline welders, gas engine overhaul men, and instrument makers. Requirements for the various classes of landsmen to be enlisted are:

Landsmen for Quartermaster; although no previous trade experience is required a general manual ability is required. Men of trades such as rigging, fabric working and wire working are desired, as are also men experienced in the operation of hydrogen plants or in the care and upkeep of dirigibles or balloons. Men in this training who display proficiency on dirigible work will be assigned to this branch. These men will also be used as sea-plane riggers, for general structure and overhauling and also inspection of dirigibles preliminary to flight.

Carpenters' mates will look after the upkeep and repair of wings, pontoons, flying boat hulls and bodies, balloons, and dirigibles, their training covering the practical application of their trade skill and general aviation work.

Machinists' mates will show previous experience in gasoline engines or any allied skilled trade such as that of electrician. These will be charged with the upkeep and overhaul of aircraft engines. Their training covers a practical understanding of aircraft engines.

Provision is made for men especially well qualified for enlistment or enrollment as carpenters' and machinists' mates to be enrolled directly for that second class rate should their skill be sufficient. The rating badge for men in this service will be the same as the regular except for the addition of double wings.

Applications and inquiries may be addressed to U. S. Navy Recruiting Bureau, 318 West 39th Street, New York, N. Y.

THE AIRPLANE AND THE WAR

While the hopes of the world are centered upon the airplane as the agency above all others by which to conquer peace and world-safety it is still the younger of the great modern war devices, the submarine having attained some phase of practicability many years before it. In the history of the development of the airplane three names, all American, stood out most prominently: Langley, Wright, Curtis. Langley did much in experimenting and in preliminarily determining the essentials for successful flight, but he was, in a way, before his time, as the most needed motor was not yet perfected. Wright also contributed much to the success of the machine and gave the world confidence by actual flight, but it is still to be said that Glenn H. Curtiss has done more to develop the practical side of aviation than any other man. To him must be given the credit of having trained more men and built more airplanes than any other individual in the world to-day, and yet it is to be remembered that he is under forty years of age.

After the declaration of war he put nearly all his time and resources at the disposal of the Government. His vast experience and his knowledge of the art has made his counsel most valuable.

It is therefore a most notable and a most commendable thing which *The American Machinist* has done in presenting in its fortieth anniversary issue a personal interview with Mr. Curtiss on the subject of airplane development, and its effect in the present world-conflict.

DECIDING FEATURE OF THE WAR

"From conversations which I have had, says Mr. Curtiss, with military men who are familiar with conditions on the western front and from the published reports which I have read of recent advances made by the Allied forces, I believe if any one element can decide this war, that element will be the airplane.

"Success in trench fighting to-day is largely dependent on artillery superiority. The army which succeeds in pouring into the opposing trenches a sufficient amount of steel has a comparatively easy time of it when the infantry is moved forward. In some instances an entire divisional staff has been wiped out by a properly placed sixteen-inch shell—a shell directed by airplane. Heavy artillery is of little use unless it can be properly directed, and, for this reason, with the wider use of this type of ordnance, the necessity for airplane observation has been greatly intensified.

"Since the failure of the Zeppelin raids in England, Germany, it is understood, has been making feverish preparation to enlarge her air force by building great numbers of speedy airplanes. News which I have had from our men in London indicate that the Germans are employing these machines for 'moonlight' raids over England and for general patrol duty.

"While I believe it is generally allowed that the Allies have won supremacy on the western front, yet, to keep it and destroy the German submarine bases, and successfully prevent night bombing expeditions, faster and larger airplanes will be required. France and Great Britain cannot materially increase their aircraft production at the present time, and it is for this reason that they look to us in this emergency.

"The question of obtaining the proper machines is not, however, the only big problem, but how to get men to man them efficiently is an equally difficult task.

"The present plan for training aviators encounters a special difficulty. That is the lack of pilot instructors accustomed to fly the speedy fighting craft. There is no one to blame for this, as the United States up to this time has not needed men possessed of this special expertness. There is a problem, however, that the Government is successfully working out, and it should not be long before we shall be able, with the help of the experienced French and British airmen, to furnish a number of expert pilots, trained in America and flying American-made machines.

TYPES OF AIRPLANES

"As to the type of planes which will be used to finish the war, I do not believe our possession of air mastery will be secured by the use of any particular size or type of airplane. All types will be needed: Flying boats for coast patrol and submarine hunting; small, speedy machines for combat work and scouting; large and powerful machines for raiding and trench bombing, and probably several types will be developed to take care of various other exigencies as they arise.

"In fact, the range is as extreme as that in the navy from torpedo boat destroyers to super-dreadnaughts. The discussion about particular types of aircraft is the same as that through which the navy passed. With a swing of the pendulum, some favored the torpedo boat almost to the exclusion of other craft; others demanded that only big-gun battleships be built. Just as an efficient navy does not consist of all big battleships, or of all submarines or all light cruisers, neither can an efficient air-service consist of only one type of plane, however successful its performance for its particular design or purpose.

"Actual fighting between men in the trenches and airplanes equipped with machine guns has been reported. Possibly a special type of machine will have to be designed for this purpose before the war is over.

"The Germans are wonderful refiners and exceedingly clever adapters. They very quickly copy French and English machines whenever they fall behind their lines, and in many cases make improvements. They will, of course, do this with the American machines. Germans, however, have shown little real inventiveness during the war, and for this reason I believe we can keep ahead of them.

"No one need doubt the ability of the American aeronautical engineers to produce craft which will be more powerful and speedier than any which have been used abroad. Best of all, we have the material and factory facilities for turning out a vast quantity of machines of any kind that may be required for use by the Allies or ourselves.

"The Government, through its many branches, has made wonderful progress in air work, and these French and English engineers with whom I have talked seem to be more than satisfied with the result of our efforts thus far.

"While I cannot, due to the Government censorship, tell much about the details of the newer type of airplanes, hydro-airplanes and flying boats, I can, without violating confidences, say that we are developing machines to-day that will be superior to anything now in use in Europe, and these in sufficient quantities to meet the demands of the program that is contemplated by the War Department."

RAISING A QUARRY REGIMENT

The Engineer Corps of the U. S. Army has been authorized to raise, by voluntary enlistment, a Special Quarry Regiment to consist of six companies of 250 men each, and to be known as the 28th Engineers, National Army. This regiment is now being recruited, and the first two companies are in training at Camp Meade, Md.

The regiment is to be made up entirely of picked men from the various quarries of the country. All trades and occupations in the quarry business will be represented. Each company will have a sufficient number of skilled men to operate a separate quarry plant.

Each company will be equipped with a complete rock-crushing and screening plant, capable of producing 1,000 tons of crushed rock per day. Churn and air-drilling outfits will be provided, and the equipment will include steam shovels, locomotive cranes, steam locomotives, cars and other standard quarrying machinery. Only men who have had experience in the handling of such equipment and those who have worked in and about quarries will be enlisted for this service.

The commanding officer will be a Regular Army Officer, the other officers of the Regiment being largely drawn from the Engineers and Quarry Superintendents who have volunteered their services, have been given the necessary military training at the Officers' Training Camps and are now commissioned in the Engineer Officers' Reserve Corps.

All men who volunteer for this service will be enlisted as privates, but those who show themselves qualified will be raised to the grade of non-commissioned officer. Any recruiting officer will enlist men for this regiment, but each man must show proper qualifications by way of experience and pass the usual physical examination. All men between the ages of 18 and 41 are eligible for enlistment if not actually drawn on the draft.

More detailed information will be furnished by Major O. B. Perry, of the Chief Engineer's Office, Washington, D. C.

A CANARY'S FATAL SONG

Our readers who are well informed as to the use of canaries and mice by miners to give warning of the presence of carbon monoxide, will readily understand and appreciate the following from a recent issue of *The Official Bulletin*:

For more than a month on a northern sector of the line the British had been secretly mining beneath the German trenches. The work was almost complete. During the operations several canary birds were, as usual, kept in the excavation to warn the workers of the presence of fire-damp,[?] which is fatal to the birds. One little songster, however, escaped from its job, flew into the middle of "No Man's Land" and, alighting on a bush, began to sing. Consternation reigned in the British lines. If a bird should be discovered by the Germans the work of weeks would go for naught, as the enemy could easily interpret the meaning of its presence and prepare to combat the sapping operations. The infantry was immediately ordered to open fire on the canary to destroy it. But it seemed to bear a charmed life. Even the sharpshooters failed to bring it down as it hopped from twig to twig. Finally the artillery had to be called on. A trench gun with a well-timed shell blew the bird and the bush and the song into nothingness.

THE GRANITE NATIONS

France, Britain and the United States have enormous interests on this continent, and they are united interests. I have always felt, Mr. President, in dealing with rocks and geology, that these three nations are the granite nations of the world. Granite, the most durable and the strongest of all rocks, combines three essential constituents, mica, quartz, and feldspar. To me, mica represents the French element of that rock, polished, smooth, shiny. Then comes the British, the quartz, so durable, lasting, resisting, typifying in a sense the British who came next as settlers on this continent; and then the feldspar, a useful and essential and also a composite mineral, which typifies also in other respects the United States. There we have the granite, the mica, the quartz, and the feldspar, each one in its own way useful and in every way necessary singly and separately, but together forming the strongest rock, typifying the nations to which we look forward to help bring peace and to form that peace league of nations which will endure forever.—*Dr. Henry M. Arni, of the British Legation, before A. I. M. E., St. Louis.*

CEMENT GUN ON OLD STONE MASONRY

About the first recorded instance of the use of Portland cement in American railway structures was the covering of old stone masonry culverts on the Erie Railroad with concrete. The frequent repointing of stone is alone sufficient justification for covering it with a cement mortar slab, in many cases; but when the stone is of a character that slowly disintegrates by "weathering," there is only one ultimate solution of the problem, namely surfacing with cement mortar or concrete. Recently a rubble arch bridge near Lancaster, Pa., was surfaced with cement mortar applied with a cement gun. The bridge was built more than a century ago, and had disintegrated badly. Loose mortar was picked out of the joints and wire mesh was fastened to the face of the masonry with boat spikes driven into the joints. Then a 1:3 mortar was shot on, covering the surface to a thickness of 2 in. The Dewey Cement-Gun Construction Co., of Allentown, Pa., covered 11,000 sq. ft. in 14 days of work with the "gun," or 800 sq. ft. per day.

DESTROYING WORKS IN OCCUPIED TERRITORY

A Reuter's Agency's report, based on a competent Belgian source, states that the Germans are finishing the destruction of works in the Liége district. Gangs of men have been put on to destroy the Cockerill blast furnaces. Besides this, all the machinery has been taken away as well as all raw materials and stocks, and the central works are being taken to pieces in order to remove all the copper from them. At Ougrée preparations have been made to pull down three blast furnaces; two are already destroyed. Seven rolling mills out of nine have been removed. At Angleur everything has disappeared. At Grivegnée everything has gone except the steel works, where the Germans are making ingots. At the Espérance works at Longdoz as soon as the first requisition papers arrived the Germans immediately began to destroy or to take away the objects mentioned, namely, blast furnaces, steel works, rolling mills, foundry, and machine shops. Everywhere also the Germans are taking away the papers and plans from the drawing offices. The situation is more or less the same all over the country. The important works of "La Providence" at Haumont (Hainaut) have been completely destroyed, as well as the power station of the same firm at Marchienne.

NOTES

The present war is producing many improved therapeutic and surgical methods that have accounted for saving the lives of thousands of wounded soldiers. Mention has recently been made in English papers of the use of electrically heated beds for men who are so desperately wounded that they were almost on the verge of death. Numerous such cases have been revived in this manner. Electric heating elements are woven into the mattress and blankets of special hospital beds.

Power boats are now near the 60 miles an hour mark. A recent record is an average of 56 miles an hour over a thirty mile course, the first six mile lap being covered at 59.5 miles per hour.

In one of the big motion picture studios in New Jersey they have a great theatrical stage mounted on a turntable so that it can be made to face the sun, or vice versa, at all hours, and thus control the shadows.

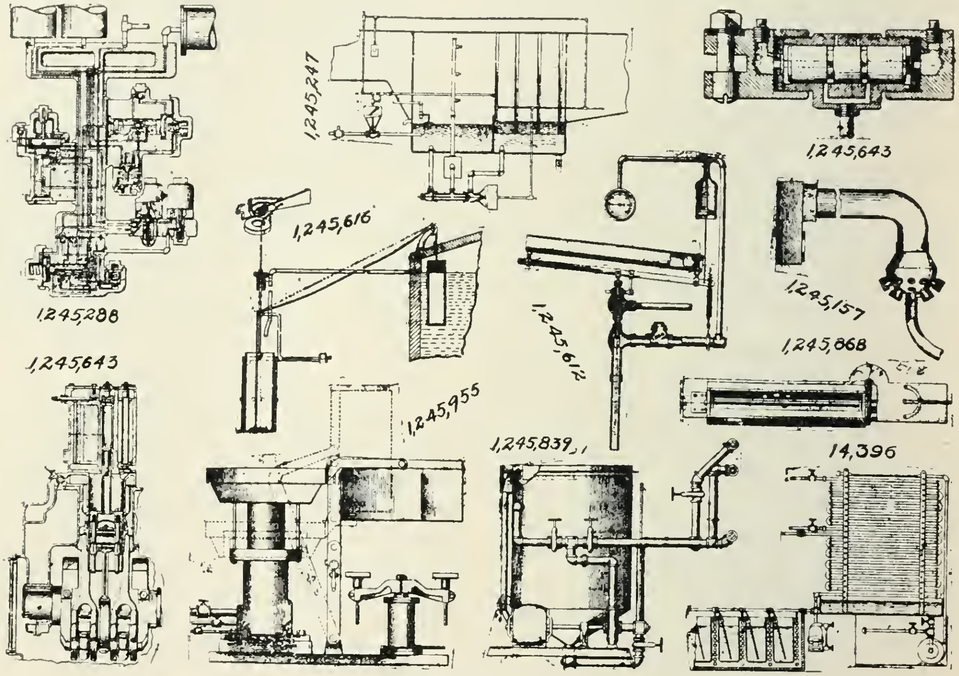
The United States Lighthouse Service is charged with the maintenance of aids to navigation along 47.192 miles of coast line and river channel. There are employed 5,796 persons, including 122 technical force, 149 clerical force, and 5,525 employees connected with depots, lighthouses and vessels.

The coefficient of friction of solid rubber tires on cement and vitrified brick roads is about 0.6, while that of pneumatic tires under similar conditions is 0.5. The coefficient of adhesion is greater than that of friction and incidentally this partly explains why a motor car stops more rapidly when the wheels are kept moving than when they are locked; hence the increased danger when a car skids if the rear wheels are locked by the brakes.

The important temperatures in window glass manufacture are the working temperature of the glass—about 1.500 deg. Fah. in hand blowing, and 1,750 deg. in machine blowing—and the "setting temperature," or the temperature at which glass retains its form, which is about 850 deg. In the liquid state in which glass is worked in machine operations, it is so soft as to be extremely sensitive to changes in temperature or variations in exterior or interior pressure exerted at the point of draw.

The first locomotive for American war-service railroads in France was completed by the Baldwin Locomotive Co. in twenty working days, and thirty engines of this type are now being turned out each day. This is in spite of the fact that the superheater boiler is used and must be constructed especially for this engine. The locomotive weighs about 166,400 pounds, and with the tender, about 275,000 pounds. Like all the equipment, it is painted battleship gray and bears the letters "U. S. A."

During cold weather we experienced considerable difficulty in pumping oil from the railroad spur to the gas works through about a quarter of a mile of 4-in. pipe. In order to cut down the pipe friction a valve was placed on the intake of the pump so that a certain quantity of air was admitted with the oil. This reduced the volume of oil in the pipes and the friction enough so that the pump could handle the oil without excessive pressure. This device saved the installation of a steam boiler to heat the oil.—*Wrinkle Dept. P. C. G. A.*



Pneumatic Patents November 6

France and England freely acknowledge that they greatly decreased their efficiency by sending their scientific men to the trenches. Although they have since withdrawn most of those still alive and are now using them in special service, the dearth of technically trained men has been and is severely felt.

Because of its cellular structure rubber sponge has several very peculiar properties. For example: it has the lowest apparent specific gravity of all solid bodies, being around 0.05, or about one-fifth that of cork. In spite of its cellular structure it is water tight, and very nearly gas tight. While it is honeycombed with minute cells, each cell is an individual unit and the rate of diffusion of gases through it is comparatively low. Because of its low specific gravity it has a very low specific volume, which thus brings its cost within range of common purposes. Perhaps one of the most important uses to which it has been put is in the preparation of life preservers. It will not waterlog, is light, conforms easily to the lines of the body, and is not to be ruined by a pin prick. A life raft made with rubber sponge is as near fool-proof as one can be.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 6

1,245,165. AIR-PRESSURE-PRODUCING ATTACHMENT FOR GASOLINE-TANKS. Reason C. Tharp and Pearley G. Buckles, Osceola, Mo.

1,245,157. HAIR WAVING AND DRYING APPARATUS. Hannah Jacobs and Harry Jacobs, New York, N. Y.

1,245,247. METHOD FOR PURIFYING AND HUMIDIFYING AIR. Adolph W. Lissauer, New York, N. Y.

1,245,288. ELECTROFLUID - PRESSURE BRAKE. Walter Turner, Wilkinsburg, Pa.

1,245,401. AIR-PUMP. John K. Tomlinson, Ronceverte, W. Va.

1,245,603. VIBRATOR. Wilfred Lewis, Haverford, Pa.

1,245,612. VACUUM-PUMP. Edward O'Mara, St. Louis, Mo.

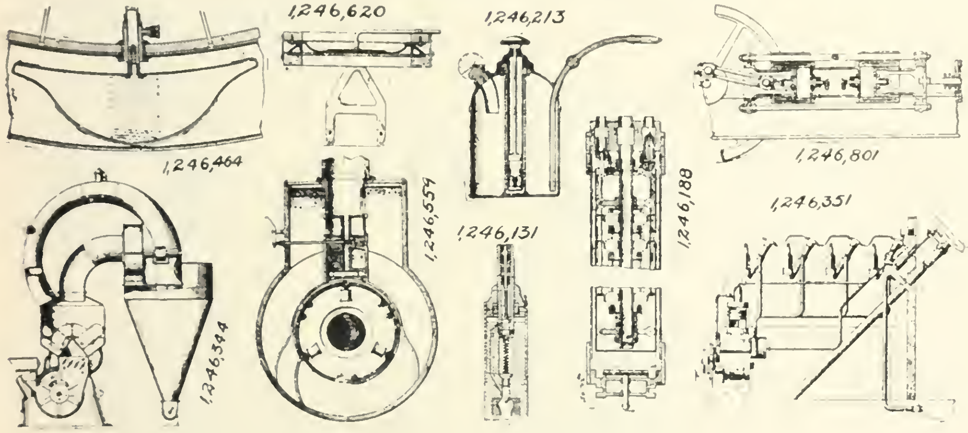
1,245,616. AUTOMATIC WATER-SUPPLY REGULATOR FOR WINDMILLS. Walter F. Pressler, Tosca, Tex.

1,245,629. PNEUMATIC CLEANER. Joseph J. Smith, Cambridge, Mass.

1,245,643. AIR-COMPRESSOR. William Everett Ver Planck, Erie, Pa.

1,245,839. METHOD OF AND APPARATUS FOR DISINTEGRATING AND DECOLORING PAPER. Stewart Waring, Evanston, and Herbert A. Hauptli, Chicago, Ill.

1. A process of disintegrating and deinking printed paper consisting in agitating a body of water containing a quantity of printed paper, saponifying the oily or fatty elements of the mixture, introducing air into the mixture during the agitating and saponifying operation, and removing the resulting foam.



Pneumatic Patents November 13

1,245,867. APPARATUS FOR CREATING ARTIFICIAL BREATHING. Otto Buchhorn, Charlottenburg, Germany.

1,245,868. PNEUMATIC CONVEYER. Charles B. Caffey, Elgin, Tex.

1,245,955. COMBINATION JOLT-RAMMING AND ROCK-OVER MACHINE. William C. Norcross, Terre Haute, Ind.

14,390 (Reissue). PROCESS OF AGITATING WATER IN MAKING ICE. Willis B. Kirkpatrick, Hartsdale, N. Y.

1. A process of agitating water by air in the manufacture of ice which consists in providing a supply of dehydrated air at a pressure of from twelve to twenty-five pounds above atmosphere, passing said air through a conduit within the mass of water to be frozen, reducing the pressure of the air before it is released to a point slightly in excess of that of the atmosphere, and delivering said air into the water near the bottom of the mass.

NOVEMBER 13

1,246,131. COMBINED TIRE-VALVE AND PRESSURE-GOVERNOR. George F. Marston, Pomona, Cal.

1,246,188. WATER-ELEVATING APPARATUS. George Franklin Van Brunt, Kewanee, Ill.

1,246,213. PNEUMATIC ATOMIZER. Eduardo Zawels and Estanislao Zawels, Buenos Aires, Argentina.

1,246,344. PNEUMATIC SEPARATOR FOR PULVERIZING-MILLS. Edward J. Steckle, Dixon, Ill.

1,246,351. STARTER MECHANISM FOR INTERNAL-COMBUSTION ENGINES. Frank E. Ten Eyck, Auburn, N. Y.

1,246,464. INFLATING DEVICE FOR PNEUMATIC TIRES. Alfred H. Randall, Bridgeport, Conn.

1,246,543. MEANS FOR PREVENTING CLOGGING OF THE WORKING BARRELS OF PUMPS. Robert E. Carmichael, Damon, Tex.

1. The method of preventing clogging of the working barrel of a pump, consisting of providing passages leading into the said working barrel, of connecting said passages to a source of fluid under pressure and of so controlling said passages that the fluid under pressure is continuously introduced to the working barrel during each working stroke of the pump.

1,246,559. FLUID-PRESSURE MOTOR. Mark S. Darling, Conrad, Mont.

1,246,620. PNEUMATIC PRINTING-FRAME. Lionel F. Levy, Philadelphia, Pa.

1,246,801. AIR-COMPRESSOR. Henry Bolthoff, Denver, Colo.

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1,246,849. PROCESS OF REFRIGERATION. John C. Bertsch, Edgewood Park, Pa.

1,246,941. ENGINE-STARTER. James Edward Sandeson, Danville, Ill.

1,247,064. MULTISTAGE BLOWER FOR PNEUMATIC CLEANERS. George W. Allen, Boston, Mass.

1,247,080. PNEUMATIC TOOL. Charles Christiansen, Gelsenkirchen, Germany.

1,247,088. SPRAYING INSTRUMENT. Thomas A. De Vilbiss, Toledo, Ohio.

1,247,149. AUTOMATIC FUEL CUT-OFF FOR OIL-BURNERS. William R. Ray, San Francisco, Cal.

1. In combination, oil-supply means and air-supply means, a cut-off valve for controlling said oil-supply means, a diaphragm adapted to be actuated by the air pressure of said air-supply means, a pivoted locking lever actuated by said diaphragm and formed with a seat, and a weighted operating lever for said cut-off valve having a laterally extending pin for engaging in the seat of the locking lever to hold said weighted lever releasably.

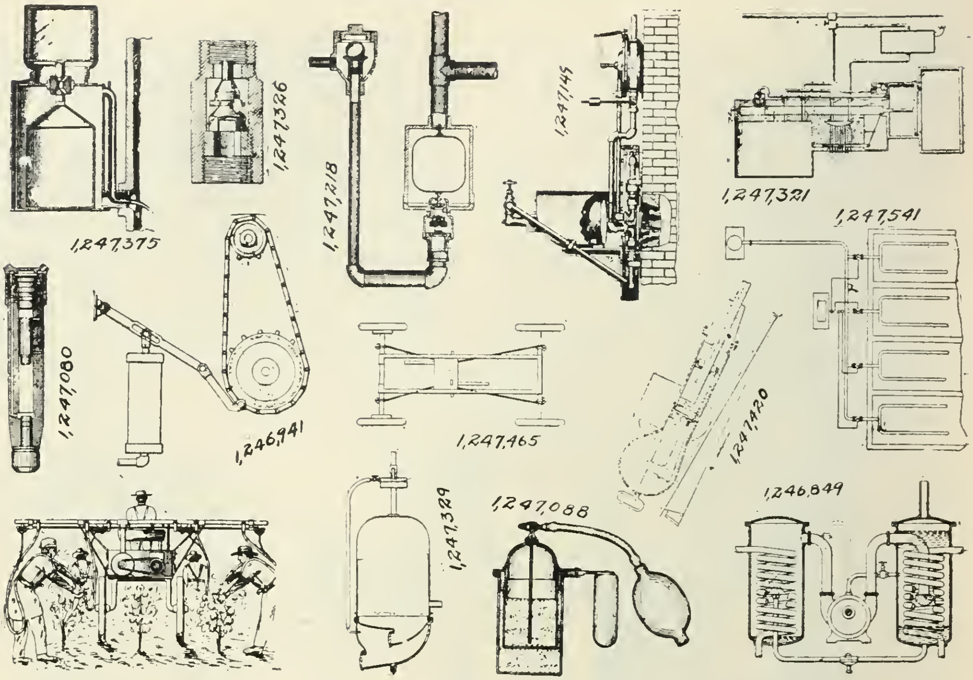
1,247,218. AIR-ELIMINATOR. William J. Burkart, Pittsburgh, Pa.

1,247,321. MEANS FOR AUTOMATICALLY LUBRICATING CAR JOURNAL-BOXES. Otto M. Paskins, Mattoon, Ill.

1,247,326. PNEUMATIC VALVE. Winfield P. Porter, New York, N. Y.

1,247,329. MILKING-MACHINE RELEASER. Ambrose Ridd, New Plymouth, New Zealand.

1,247,375. AIR-MOISTENER FOR STEAM-CONTAINERS. John A. Clark and Clifford H. Coon, Brooklyn, N. Y.



Pneumatic Patents November 20

1,247,387. COTTON-PICKING MACHINE. William L. Fodrfa, Little Rock, Ark.
1,247,420. MINING-MACHINE. Nils David Levin, Columbus, Ohio.
1,247,465. AIR-COMPRESSING AND SHOCK-ABSORBING SYSTEM FOR VEHICLES. Richard G. Spink, Gibbon, Nebr.
1,247.541. PURIFICATION OF SEWAGE AND OTHER LIQUIDS. Walter Jones, Stourbridge, England.

1. The process of purifying sewage or other impure liquid by supplying the sewage or impure liquid to a tank, supplying or delivering air in small bubbles, periodically, a plurality of times at different points to the liquid in the tank during its treatment, until it is purified, and running off the purified liquid.

NOVEMBER 27

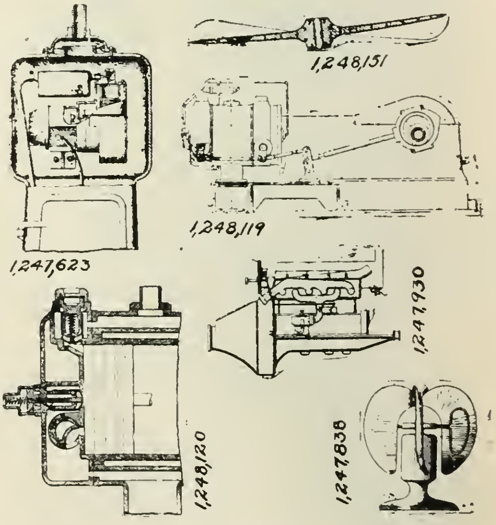
1,247,623. AIR-DISPENSING MEANS. Samuel D. Black, Baltimore, and Alonzo G. Decker, Orangeville, Md.

1. The combination with a post or pedestal having an upper compartment constituting a hollow head and having air intake and outlet passages located in different walls of said head, an air cooled air compressor mounted in said hollow head and arranged to draw air into said head through said intake passage and expel it through said outlet passage.

1,247,835. PNEUMATIC SHOCK-ABSORBER AND AIR-COMPRESSOR. William H. Holden, Idaho Falls, Idaho.
1,247,838. FAN. Fred C. Howe, New Haven, Conn.
1,247.837. SUCTION-SWEEPER. Howard Earl Hoover, Chicago, Ill.
1,247,930. COMPRESSION-BRAKE. Bert L. Campbell, Detroit, Mich.

1. In a compression brake for vehicles, an internal combustion engine having cylinders and pistons operable in the engine cylinders, an exhaust manifold for the engine cylinders, an intake manifold for the engine cylinders adapted to communicate with the atmosphere, means including valves adapted to close said exhaust manifold and open said intake manifold to the atmosphere so that air is compressed in said engine cylinders to retard the action of the pistons therein.

1,247,951. AIR-REGULATING VALVE. Henry M. Fuller, Salt Lake City, Utah.
1,248,119-20. AIR-COMPRESSOR. Fred D. Holdsworth, Claremont, N. H.
1,248,151. AIR-PROPELLER. Samuel D. Mott, Passaic, N. J.



Pneumatic Patents November 27

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

Vol. xxiii FEBRUARY, 1918 No. 2

COMPRESSED AIR FOR FORGE SHOPS

BY CHARLES A. HIRSCHBERG.

The modern manufacturing plant and many remodeled older ones are resorting to electric current, direct motor drive, in place of steam engine and line shaft, because of its greater convenience, cheaper maintenance, generally neat and cleanly appearance and the many economies it makes possible in the operation of the private power plant. In some cases where a serving company is available the power plant with its boiler equipment and coal pile have disappeared entirely.

The forge shop can be electrified to as great advantage as the balance of the manufacturing plant. A few establishments, caring nothing for precedent, have explored its possibilities, and in these explorations have discovered that it remained but to employ the proper means of transmission to make the innovation a complete success. Compressed air, so often a companion of electricity and like it a power transmitting agency—not a prime mover—has been called upon to supply what might be termed the connecting link between the electric motor and the hammer.

In reality such a plant may be termed an electro-pneumatic power forging plant. The equipment consists of an electric-motor-driven air compressor supplying compressed air instead of steam to the forging hammer. This equipment is usually installed in an out-of-the-way corner of the forge shop. It requires no constant supervision and has many other advantages; and the following discussion and typical examples are for the purpose of acquainting the forge shop with the practice and to place at its disposal the experience of those who have pioneered.

At the start it may be well to say that there are no mysteries connected with compressed air. It is often misunderstood because it is given only passing investigation. It is easier to deal with than steam and compares favorably in cost with other forms of power and, under certain conditions, such as those treated on in this article, the advantage is decidedly on its side.

For our purpose we will classify the general

FIG. I

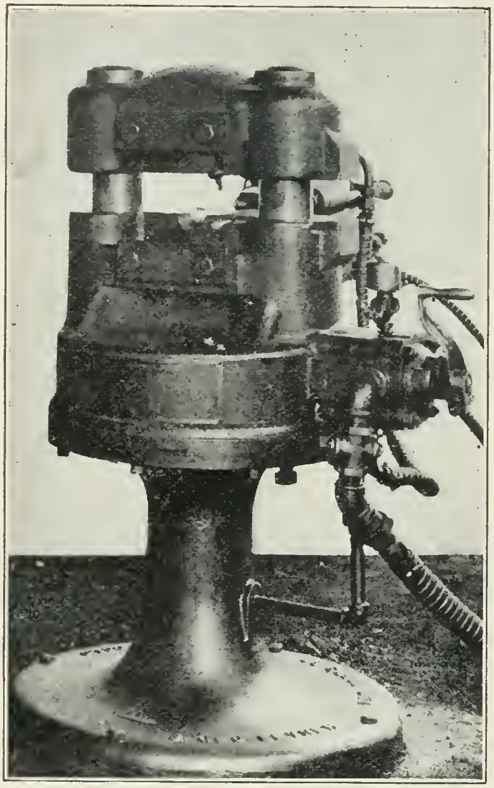


FIG. 2

subject of forging into several groups, as follows: Upsetting, bending, forming, pressing, forging.

UPSETTING.

Perhaps the most common example of this class of work (entirely overlooked because we have learned to distinguish it by some other name) is that of forming heads on rivets by means of hand-held pneumatic riveters, yoke riveters, etc., as illustrated by Fig. 1.

This work bears the ear marks of many forge shop operations; for instance, upsetting bolt heads, heading pins and forming collars. Which brings to mind the fact that the coal and metal mines have long employed a type of pneumatic forging hammer, commonly called a drill sharpener, see Fig. 2, for upsetting various forms of shanks on drill steel, also drill bits, as well as pins, bolts, pipe hangers, etc. In Fig. 3 is shown a set of dies for forging bolt heads and sample of stock and finished work.

In fact, an appreciation of the meaning of this service has not infrequently caused the mine blacksmith to appropriate a discarded reciprocating rock drill, installing it, as shown in Fig. 4, for many odd jobs of forging. The drill minus the shell is fastened to a column or vertical support and an ordinary anvil fixed in position beneath the ram. The power connection consists of an air hose, coupled from the air line to the usual inlet of the drill. Fig. 5 is interesting in that it shows the mine drill sharpener applied to nosing shrapnel..

Lately shipyards are adopting them for upsetting heads on long bolts or rods of which so many are used in wooden ship construction. They are particularly adapted for this work, because the principle of forging or upsetting is such as to make the length of rod immaterial.

UPSETTING, BENDING, FORMING.

Railroad shops have been quick to recognize the advantages of compressed air applied to many operations of upsetting, bending and forming, and, as a result, have developed a number of machines for upsetting heads on bolts and king pins, for forming hooks and eyes, pipe clamps, angle straps, etc.

In Fig. 6 is shown one such 70-ton machine and termed by the railroads a "bulldozer." Its employment has a marked effect in the reduction of the cost of many special forgings, increased output as well as in an improvement in the quality of work.

Referring to Fig. 6, the machine, a railroad shop bulldozer, consists of two 30-inch cylinders which are attached to a frame made up of two 16-inch I beams, with the face plate attached at their top. The cylinders were placed tandem, enabling the concentration of the full power of both cylinders at one point. The arrangement is also such that one cylinder may be used independently of the other on light work. A working pressure of 70 pounds per square inch is employed.

BULLDOZER RECORDS.

Pipe clamps of various sizes are formed in

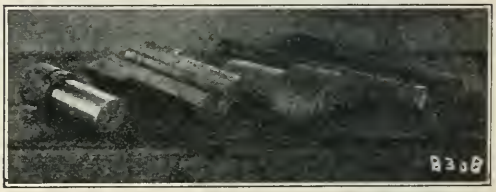


FIG. 3

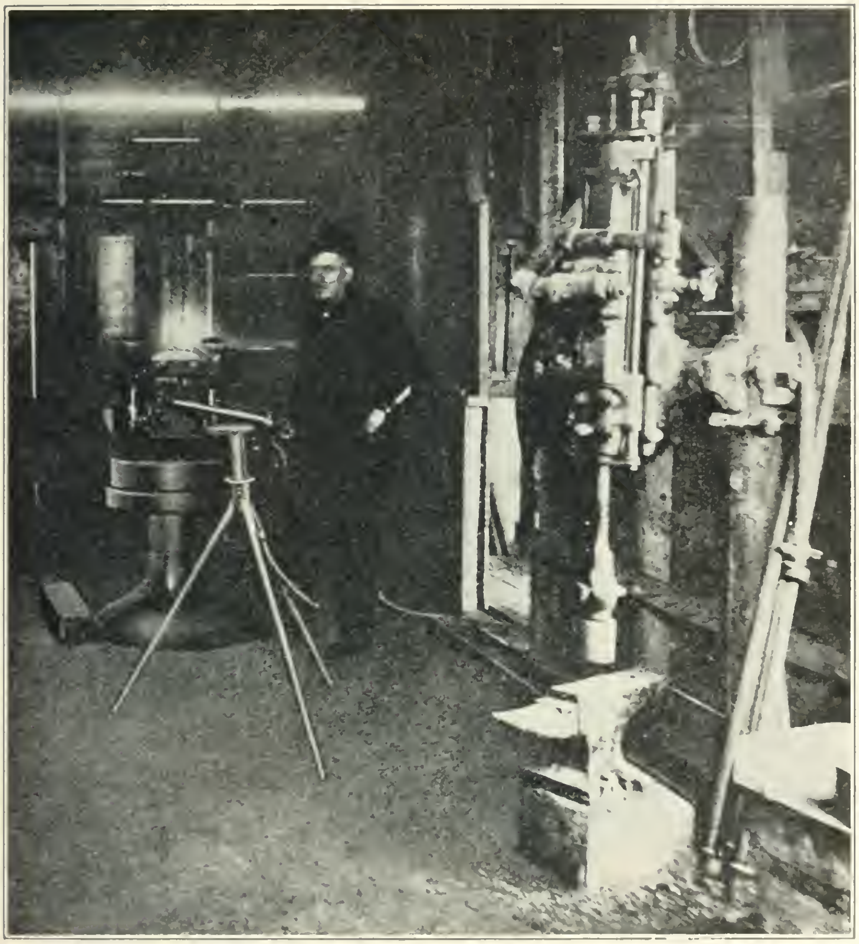


FIG. 4

one minute each. Locomotive main rod straps, weighing 236 pounds, have been forged in 47 seconds. Valve yoke forged complete in 5 minutes. Turnbuckles forged and welded in two operations, smoke arc braces in one blow. From one to three minutes is required for changing dies. In most cases the actual changing of dies and the forging operation is done in less time than that required for heating.

This machine, first installed experimentally, proved such a great success that its manufacture in standard sizes was undertaken by a Chicago manufacturer.

In Fig. 7 is shown a portable machine designed for bending pipe. The dies are changeable, making it possible to handle an almost unlimited variety of shapes. Any size of pipe up to 2½ inches can be worked cold without filling. It does not flatten or split the pipe. Tests show that this machine will put a 90 degree angle in a 2-inch pipe in two minutes. It operates on an air pressure of 80 to 100 pounds. While sold for pipe bending, it may also be applied to the bending of various shapes of bar iron, angles, etc.

The above machines are strictly pneumatic. They have been illustrated and described chiefly to prove that pneumatic forging is not an experiment.

AIR SUPERSEDING STEAM.

In reading the following cases it will be evident that accident played an important part in the conversion from steam to compressed air operation, and yet the dominant note was the need for electrifying the forge shop so as to conform with the balance of the plant practice.

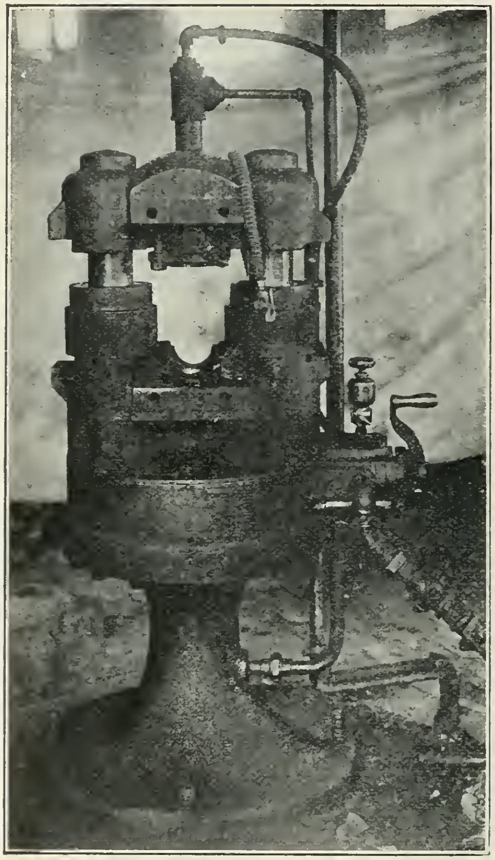


FIG. 5

The Buffalo-Pitts Company, of Buffalo, N. Y., was one of the first to demonstrate the advantages of air operation for forging hammers. They made the change primarily because of the fact that the rest of the plant was operating on electric current. It was desirable to electrify the one big steam hammer for the operation of which a battery of high pressure steam boilers were being run. A motor driven compressor was installed not only to operate this hammer, but many other pneumatic devices.

Another pioneer in this direction is the Nisqually-Russel Car & Locomotive Works, of Tacoma, Wash. About five years ago (1912) the city boiler inspector condemned the boiler in this plant. It was chiefly used to furnish steam for the large hammer. Instead of buying a new boiler, the old one was converted into a vertical air receiver and a belted-to-motor compressor installed to furnish power to the hammer.

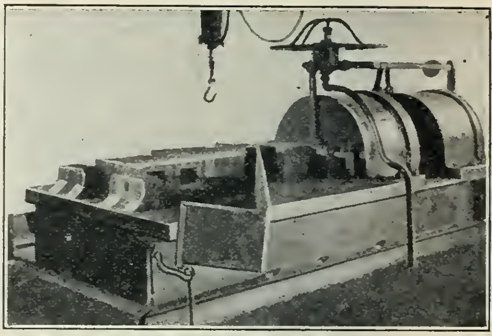


FIG. 6

It is stated that $50.00 a month is a liberal estimate for the power consumption of the compressor, whereas the fixed charges under the old system were $62.50 per month for the licensed fireman at $2.50 per day, and $31.25 for 12½ tons of coal at $2.50 per ton, making a total of $93.75 or a saving in favor of air operation of $43.75 a month.

In addition the air is used for operating other tools, therefore the saving is in reality greater than the figures show. On the above basis, however, the saving per year in this plant is $525. This company further stated that aside from the saving there is a decided advantage in the increased efficiency of the hammer, as they were only able to carry 90 pounds pressure on the boiler and they figured this gave them about 60 pounds working pressure at the hammer. The air, on the other hand, is practically at the same pressure at the hammer as in the receiver, and they got fully 90 pounds on the piston. It is further stated

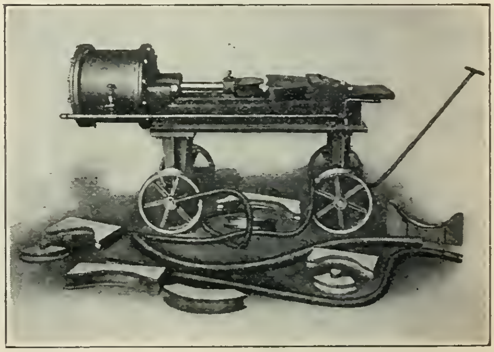


FIG. 7

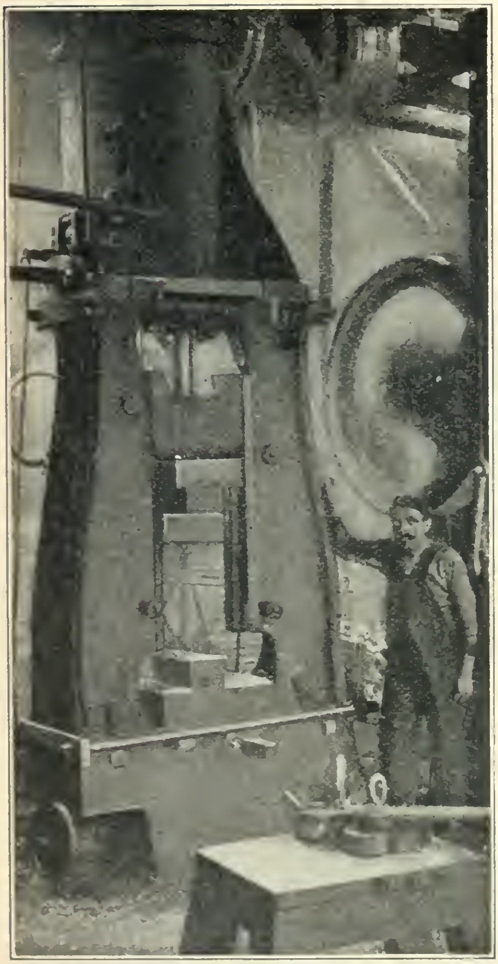


FIG. 8

that "the air is quicker, and although not quite so elastic as the steam (?), is nevertheless very satisfactory."

Another example is related by the Franklin Institute "Journal," as follows:

"The Cumberland County Power & Light Co., of Portland, Me., has recently been successful in the conversion of steam-hammer equipment to electro-pneumatic service, a pioneer installation being made at the plant of the Marine Hardware & Equipment Co. At this plant a 1,200-pound Bement-Niles steam hammer was in service, steam at about 90 pounds per square inch being required for many hours daily. To avoid condensation troubles, it was necessary to run the hammer practically continuously. As eleceric-motor drive had been adopted for other purposes throughout the plant, it was found possible to do away with the demand for continuous high-pressure steam by adapting the steam hammer to air operation and installing a motor-driven compressor to supply air for this purpose and other requirements. The valve of the steam hammer was rebuilt for a fit of 0.0025 inch compared with a previous fit of 0.005 inch under steam service. The hardware company purchased a 50-hp. 220-volt, three-phase, Westinghouse squirrel-cage induction motor designed for 900 revolutions per minute, and belted it to a 12-inch and 7-inch by 12-inch compressor delivering air at 90 pounds to the storage tank supplying the compressor. A branch exhaust terminating in two ½-inch pipes was led down the frame of the hammer to outlets directed upon the working anvil surface, so that all chips and scale are immediately blown away in operation. It was found that harder and quicker blows could be struck

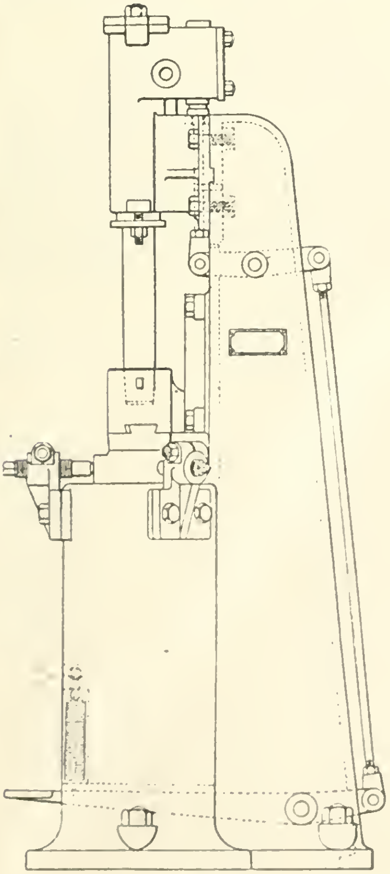


FIG. 9

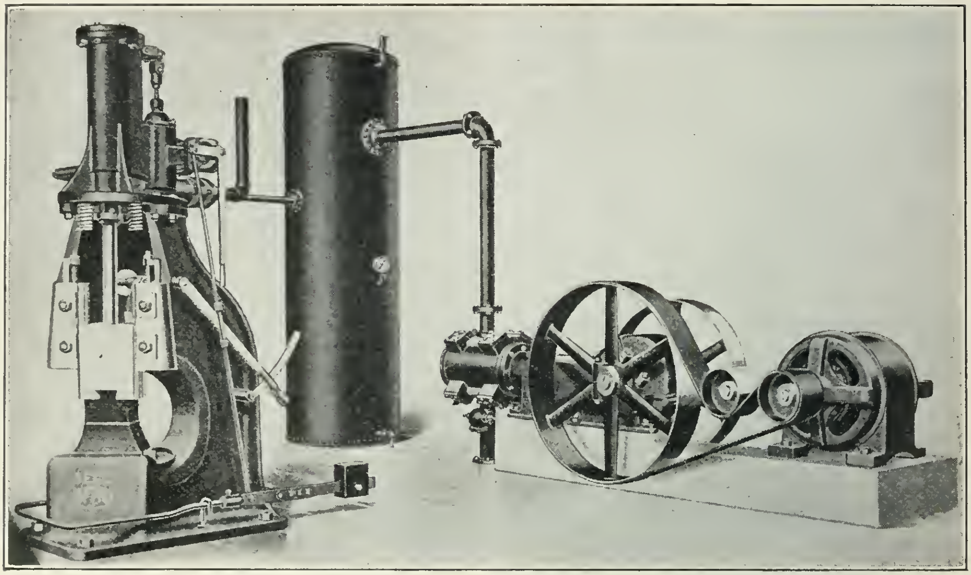


FIG. 10

than under steam conditions." The hammer installation is shown in Fig. 8.

Manufacturers of forging hammers have begun to realize the importance of meeting this demand for an electrified forge shop and have recently developed machines especially adopted for pneumatic operation.

In Fig. 9 is shown a pneumatic drop press designed for stamping sheet metal hot. Sizes range up to 46x72 inches, face of hammer. The power consumption ranges from 60 cubic feet of free air per minute for the smallest size, to 200 cubic feet for the largest at a pressure of 90 pounds.

Other drop hammers have been designed which eliminate the board, friction rollers, gears, clutches and other such appurtenances which mark the ordinary steam drop hammer. Compressed air at a pressure of 60 to 100 pounds is required, striking a blow of between 250 and 350 pounds. The air consumption is but 3 cubic feet of free air per minute at 60 pounds pressure, or about 5 cubic feet at 100 pounds pressure.

The Buffalo Foundry & Machine Co. of Buffalo, N. Y., are now supplying their bell hammers for compressed air operation. Fig. 10 shows a typical plant, consisting of the hammer, a receiver and short-belt motor-driven compressor, complete with necessary valves and gauges. It is claimed for these outfits great flexibility and the same sensitive control as obtained from steam hammers. The force, position and rapidity of blow is under absolute control and can be varied instantly at the will of the operator.

Power is only used when work is actually being done and in forging the work is in direct proportion to the power being used. Maximum power is always available when the forging is at the highest temperature and, therefore, in the most plastic condition.

COMPARISON OF AIR AND STEAM OPERATION.

Compressed air is lively and instantly available for use, so that there is no delay when starting up in the morning or any time it may be wanted. Lubrication is simplified. When starting up the steam hammer it is usually cold and the steam condenses, the lubrication is partly washed out, and there is a lot of water dripping, so that you cannot put a forging under the hammer at once. If you do, the dripping water is likely to spatter and scald the operator. Nor can the forging always be left in the fire, waiting for the water to stop dripping, because it is liable to burn, and all this happens several times a day unless the hammer is in continuous use.

Fig. 11 illustrates a British pneumatic forging hammer. The author is indebted to the "London Engineer" for the following description:

"In the construction of the hammer itself the makers have followed very closely the design of their usual smithy steam hammers, believing this to be the most satisfactory form.

The hammer, instead of being operated by steam, is worked by a double-acting pump placed immediately behind, which supplies air in the place of steam at the top and bottom of the hammer cylinder at each stroke. The pulleys and crank are placed low down, in order to ensure steadiness for the hammer, and are of very compact design, so that they may be arranged within the standard. There are consequently no projecting parts, the hammer occupying scarcely more space than a steam hammer of similar capacity. A diagonal position has been given to the anvil block in order that the pallets on all sides may be accessible, and to allow of long bars being worked in either direction across the anvil. The hammer is controlled by a single valve, which is placed between the cylinders, and by varying the position of this valve by either hand-lever or foot-lever, the operation of the hammer is promptly and easily regulated by the attendant. When the levers are in their top position air is forced only under the hammer piston, and the tup is held at the top of its stroke, and remains stationary there. On either lever being depressed, the air passes alternately above and below the hammer piston, and the hammer begins to work. The further the lever is depressed the heavier the blow, until the full blow is given. Thus light or heavy blows, with long or short strokes, can be struck at will, the regulations being easy, accurate, and instantaneous. As soon as the lever is released the tup rises to the top of its stroke, and remains there. Another useful feature is that the tup can be held firmly down on the anvil when it is required to use the hammer as a vise. This frequently is convenient for bending work, and for holding it during various operations. We have had an opportunity of inspecting one of these new pneumatic power hammers in operation at Messrs. Massey's smithy, and also specimens of the work done, which afforded proof of its efficiency. The work comprised all varieties of forgings; and as a test of the largest work that can be produced by a 3-cwt. hammer as shown in the illustration, a steel billet 8 inches square was drawn down at one heat to 2¼ inches square and 28 inches long."

Of the actual transmission of the air for the service here spoken of very little need be said. It is carried in pipes the same as steam, but is more easily handled. As already brought out, there is no condensation and it may be carried any distance with very little loss in transmission.—*American Drop Forger.*

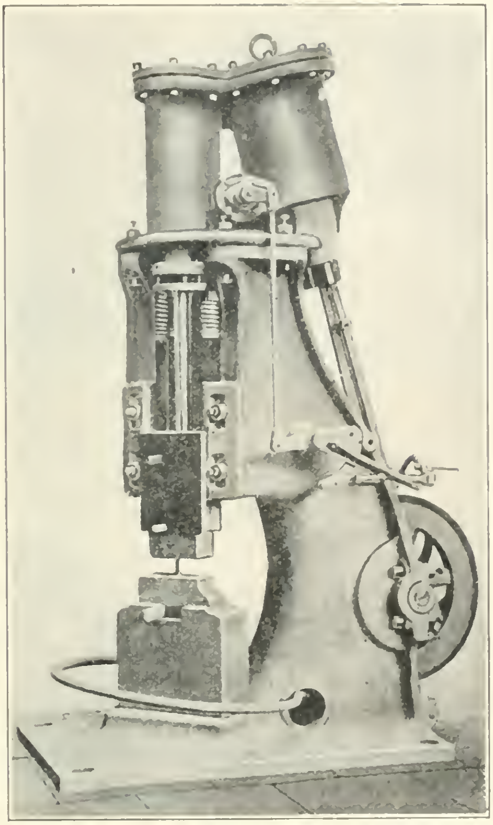


FIG. 11

DETERMINING COMPRESSED AIR CONSUMPTION

BY HARRY H. BARCLAY.

One of the perplexing problems for foundrymen to solve accurately is involved in ascertaining the amount of compressed air used by air-driven machines. From indicator cards the cost of all of the air used can be determined readily, but to ascertain the actual cost on each separate casting or job is not so easy of accomplishment. Sometimes it is desirable to ascertain how many cubic feet of air are used in certain operations. Unfortunately, the tables compiled by authorities on the amount of air that will flow through an opening of a certain size in a given length of time, are not always applicable to existing conditions in casting plants.

Desiring to secure information regarding the amount of compressed air required per mold by different sizes of foundry vibrators, we proceeded as follows:

A small air compressor was used with a

shut-off valve located between the compressor and the tank and in the latter the air pressure was raised to 90 pounds. The valve was closed and with a stop watch the time was noted that elapsed for the vibrator to reduce the pressure to 70 pounds. It may be assumed that for all practical purposes this would be equivalent to 80 pounds mean effective pressure, the amount in most general use in foundries. To illustrate in even figures, it will be assumed that the tank holds exactly 10 cubic feet of air and that it takes the vibrator exactly two minutes to reduce the pressure from 90 to 70 pounds. Therefore we figure that the vibrator used 10 cubic feet of air in two minutes. By actual tests it has been found that the average time the vibrator is working while the molder is drawing a pattern is about 15 seconds and, therefore, we get eight molds with 10 feet of air and the vibrator uses 1¼ feet of air per mold. This same principle may be applied to any air-driven tool or molding machine and we believe that the results are more nearly representative of actual conditions than theoretical calculations.—*Foundry.*

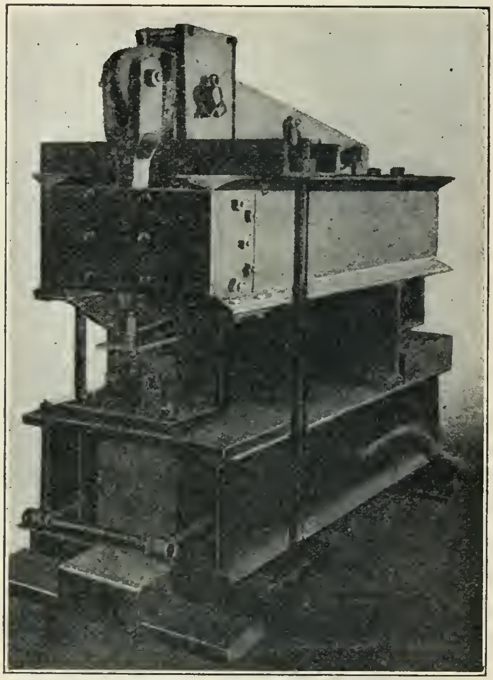
A HOME-MADE PNEUMATIC PUNCH

BY FRANK J. BORER.

The photograph shows a pneumatic punching machine which has now been in use for more than a year at the Elizabethport shops of the Central Railroad of New Jersey and has given entire satisfaction as regards service and output of work.

The frame of the machine is constructed from second hand bridge material and the few forgings required were made in the blacksmith shop. A second hand 16-in. air brake cylinder was used and no material had to be purchased to construct the machine, thus reducing the cost of construction considerably.

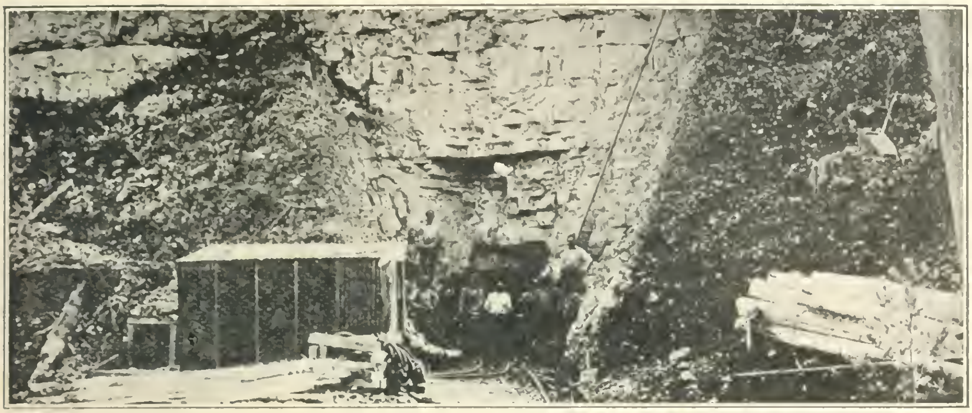
It is not the purpose of the writer to advocate the construction of a machine of this kind instead of purchasing a regular punching machine, but rather to draw attention to the fact that one or more machines of this kind could be used to advantage in small shops, in repair yards, scrap yards, etc., where the expense of a regular punching machine would be too great or where other difficulties, such as obtaining the necessary power, proper foundation and housing, limited floor space and the like would prohibit the purchase of a punching machine of the standard type.



HOME-MADE PNEUMATIC PUNCH

The pneumatic punching machine shown here does not need a special foundation and, in fact, can be made portable. Its capacity is sufficient to punch 15/16-in. holes through ½-in. iron or steel plates or its equivalent, with 90 lb. of air pressure. The power is obtained from the regular shop air supply line with a 1⅛-in. hose of suitable length. It is connected to the inlet part of a Westinghouse straight air brake valve. (It was found that this style of valve is more durable, easier to operate, and requires less repairs than does a three-way cock.) The air brake valve controls a 16-in. brake cylinder. When air is admitted to the cylinder, the piston engages a lever having a ratio of 4½ to 1. Punch dies and punches are made of the same dimensions and shape as those furnished with standard machines.

The straight air brake valve is operated by foot power, a spring attachment keeping the handle of the valve in the release position when not in use. The machine occupies a floor space of 3 ft. by 5 ft., and is about 5 ft. 6 in. high.—*Railway Mechanical Engineer.*



PORTAL OF HOMESTAKE HYDROELECTRIC TUNNEL

RAPID DRIVING OF A SHORT TUNNEL

BY H. L. HICKS

In driving the Homestake hydroelectric tunnel in the Black Hills of South Dakota, from Apr. 14 to Aug. 31 of last year, fast progress rates and low repair costs were realized.

The development consists of two tunnels, Iron Creek, 1096.7 ft. in length, and Long Tunnel, 3931.4 ft. With a 16.5-ft. adit these totaled 5044.6 ft. The work was contracted for by William B. Arndt.

The ground was a medium hard limestone for almost the entire distance, the exception being 200 ft. of every hard flint. The tunnel measures 7x7½ ft., but over-breakage would make the average dimensions greater than 7x8 ft. Work was conducted from six headings, compressed air for all being supplied by a 537-cu.ft. steam-driven compressor. The air pressure at the compressor ranged from 115 to 120 lb. and the lowest pressure at any of the drills was 90 pounds.

All the drilling was done with "Jackhamers," four of the wet type and six of the dry type. Nine drills were operated and the tenth held as a spare. The four water-feed machines were clamped in feed shell mountings of a new type (Fig. 1) and used with 3-in. single-screw columns. The other drills were, by the operators' preference, hand-held to save time, as the drillers could get back to work as soon as the heading had been shot.

The drilling round consisted of 14 to 20 holes, the usual layout being four 7-ft. cuts and ten 6-ft. side holes. Cross bits on ⅞-in. hexagon steel and ⅞-in. 60% powder were used throughout. Machine-sharpened steels were supplied from a central blacksmith shop.

The progress record is incomplete, due to periods when labor shortage made it necessary to halt work at one or another of the headings. The individual heading records are, however, rather remarkable. For instance, over a period of 41 days ending May 26, one heading was driven 8 ft. per shift or 24 ft. per day, the total being slightly over 1000 ft. Another heading, started May 2, was driven 350 ft. in 23 days of 3-shift work, running ten men per shift, using two drills. Still another case of consistent progress was that of a third heading, where 1543 ft. were driven in 86 working days between May 3 and Aug. 10, with 14 men per shift handling two drills. During this run the round was shot seven times every two days while at the other headings they shot but three times each day.

As to the last-mentioned heading, the contractors comment that "the men never saw the inside of these machines and I never had one of them in the shop until the heading was in 1400 ft." indicates that little drilling time was lost and explains the excellent average of 17.9 ft. per day at this heading.

Summing it up, the Homestake tunnel was driven fast when a full crew made it possible.

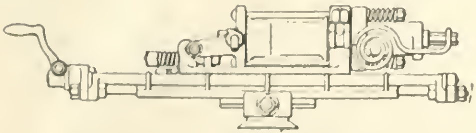


FIG. 1. SPECIAL DRILL MOUNTING

It is also to be noted that the drills set a good mark in low upkeep cost, the contractor recording a total repair expense of $289.85 or 5¾ cents per foot of tunnel.—*Engineering News-Record.*

USE OF COMPRESSED AIR TO PRODUCE CLEAR ICE

In the last few years great improvements have developed in the artificial production of ice for domestic use, and especially in the making of clear, solid, transparent ice from water, instead of the so-called "snow" ice which everywhere is very properly objected to. The most important detail of operation has been the use of compressed air for agitation during the process of congelation. This matter is interestingly discussed in a paper by Van R. H. Greene before the American Society of Refrigerating Engineers.

It is a familiar fact that all water contains air, and the presence of this in the water during the freezing period breaks up the crystal formation of the ice in such manner as to preclude the possibility of its freezing clear. This air can be expelled from the water either by boiling or by agitation, so as to drive the air particles to the surface. This latter principle is the one used in modern raw water can ice plants. The water in the freezing can is kept in continuous agitation by blowing air from an outside source into it, thereby maintaining a constant agitation. The agitated water washes the surfaces of the forming ice and drives to the surface the air particles, which otherwise would adhere to the ice. That this is true is proven by the fact that rubbing one's hand over the surface of partly frozen ice in the can enables one to judge by the degree of roughness whether the finished ice block will be clear or opaque. This means, then, in so far as the effect of air in suspension is concerned, that it is overcome by the present-day agitation processes, and it requires only an analysis of the water as to its mineral content to determine its suitability for manufacturing perfectly clear blocks of ice.

In order to keep the air passages always open, a pressure of 17 to 20 lb. per sq. in. must be exerted at the end of the air tubes to agitate the water continuously from the time the can is filled until the ice block is frozen solid. Therefore, in the modern high pressure raw water can systems theoretically it requires only a pressure of 20 lb. in the air laterals to produce the desired results.

HIGH PRESSURE AIR SYSTEMS.

At the present time there are in use two standard high pressure air agitating systems. One has the air tube suspended from the short side of the ice can, hanging inclined, so as to protrude into the ice itself without coming in contact with the walls of the can. In the other method a small brass or copper tube is soldered along the side or corner of the can, down to the bottom. In both of these systems a pressure of approximately 30 lb. is kept in the air laterals to produce the necessary air agitation.

A certain amount of air being contained in all water, so, likewise, there is a certain amount of water vapor suspended in air. When the air is cooled, this water vapor condenses in the shape of dew. The moisture thus precipitated tends to adhere to the sides of the drop pipe in the shape of ice, accumulating slowly but steadily until the air supply is shut off by the freezing up of the tube opening. To eliminate this entrained moisture the air must be subjected to a drying process, which usually includes compressing and cooling to such an extent that when the air is again expanded its dew point will be below that of the surrounding medium. This is much more difficult to accomplish where the pipe is in direct contact with the ice can, and therefore affected by the low temperature of the brine, than it is when the air tube is surrounded only by the forming ice. In the first case the air must be cooled to at least 20 deg. F., while in the second case successful drying is accomplished by cooling to at most 40 deg. F. To avoid the possibility of condensed water freezing in the dehydrator, used with the suspended-tube system, the pressure is kept a little higher than is absolutely necessary for holding the air temperature at 40 deg. F., which is sufficiently above the freezing point to prevent trouble. In case it is desired to operate with a pressure of only 20 lb. per. sq. in., effective drying can be produced by lowering the air temperature to 20 deg. F. with no more risk or trouble than in the fixed-tube system, where a temperature of 20 deg. is necessary to make this system operative under a pressure of 30 lb.

Much has been written on the chemistry of raw water ice, and great are the differences of opinion on this subject still, but unfortunately it cannot be made the essence of this paper. I shall, however, add some useful observations pertaining to this subject from personal experience in the field.

QUALITY OF WATER IMPORTANT.

The average city water contains little mineral matter in suspension, except at such times as the spring freshets cause the water to become turbulent. Thus, an adequate filter may not be necessary during the major part of the year; still there are times when heavy drains are made upon it, and for this reason it should be sufficiently large to withstand this abuse and at the same time not become inoperative by clogging up. It is safe to say that water containing mineral matter in suspension in excess of two grains per gallon will not make clear ice without the installation of the necessary filtration system.

Another source of great trouble in raw water ice making is the organic matter which is always present. This is responsible in most cases for the yellow core seen in the product of some raw water ice plants. This yellow core becomes objectionable if the organic matter exceeds two grains per gallon. When present in smaller quantities, it should be removed by the addition of alum to the water in conjunction with the filtration system. If the organic matter is much in excess of two grains per gallon, then clear ice can be made only by the removal of the core prior to the ice block being frozen solid. Oxide of iron present in quantities exceeding 0.05 gr. per gal. will produce a similar discoloring deposit, and therefore requires treatment for its removal.

Calcium carbonate, in almost any quantity, will produce a lime deposit in the core of the ice block, and to prevent this it should be removed by a lime apparatus constructed for this purpose. It is generally safe to say that waters containing more than four grains of calcium carbonate per gallon should be treated for the removal of this lime, regardless of whether it is the intention of the operator to remove the core or not, as in practice it seems difficult to effect the complete removal of this substance by core sucking alone.

THE AIR SUPPLY.

Different kinds of water require different rates of agitation. With average water containing up to 15 gr. of total solids per gallon, from 0.2 to 0.25 cu. ft. of free air per min. should produce the necessary agitation to effect the freezing of a clear 300 lb. block of ice. With waters containing solids in excess of this amount the agitation should be materially increased.

In one plant, clear ice was frozen with only about one cubic foot of free air entering the ice can during the early stages of freezing and this quantity was gradually reduced until the ice block was frozen. Of course, a plant of this character is far too complicated to be called a commercial success, but the object of the experiment was to find out under what conditions marketable ice could be made from the particular water in question.

Practically, the limit of quantity of air which can be successfully handled per can on a standard high pressure system throughout the entire period of freezing is approximately 0.4 cu. ft. per min. If more than this amount is supplied to a block which is two-thirds frozen, the agitation becomes so violent that finally no water is left in the core.

THE REACH OF THE WAR

The following items, not apparently related, are taken from a single article in a recent issue of the *Saturday Evening Post.*

CANARIES AND MICE FOR THE TRENCHES

One day not long ago the War Department received a telegram from General Pershing, reading:

"Send one thousand canaries and one thousand white mice."

The message was sent to the chief purchaser for the expeditionary forces. He read the words and sent the dispatch back to the Secretary of War with the request that it be uncoded. The code room of the War Department returned it with a note saying that it could not be uncoded, that it was just a plain telegram.

The purchaser was baffled. He did not know whether the telegram was a joke or an order, so he consulted a former United States military attache in France.

"Do you suppose that General Pershing actually wants white mice and canaries?" he asked the captain, handing him the cable.

"Yes, sir!" was the military reply. "White mice and canaries are placed in the first-line trenches because they can detect poisonous gases much quicker than the soldiers. When a soldier sees a canary bat its wings or a white mouse trying to bury its nose he understands that it is high time for him to put on his gas mask. White mice and canaries have saved thousands of lives in France, and we should supply our army immediately."

It is hardly necessary to add that the United States purchased the white mice and canaries at once and shipped them to France, and in doing so we almost exhausted the supply.

BARGAINING FOR LOCOMOTIVES.

One day General Pershing telegraphed for several hundred locomotives to be used on the railroads which American engineers are constructing in France. The order was sent to a former president of a Mid-Western railroad now acting as chief purchasing agent for General Pershing. This official went to the president of a large locomotive concern. He informed the manufacturer that the United States needed so many hundred engines immediately for service abroad.

He brought the specifications and asked for an immediate estimate of cost. The president of the company said that in view of war conditions, of the high cost of materials and labor, and because the Government desired immediate delivery, the price would be $75,000 per locomotive.

"I cannot understand why the price is so high," the official is reported as having said, "because when I was the chief executive of a Western road I bought these same engines for $50,000 each. In view of this the Government will not pay $75,000 each on this order."

He returned to Washington, unable to come to an agreement with the manufacturer. Being one of the men more or less officially responsible to President Wilson, he informed the Chief Executive that he believed he could purchase the engines for $50,000 if he could be assured of the President's support. The President told him in his very definite and firm way that he should buy the locomotives at whatever price he considered reasonable to the Government and the manufacturer. In doing this, the President said, he could be assured of the Government's support.

The next day the Government purchaser went to the manufacturer with a contract. He said in effect:

"The United States Army in France needs —— hundred locomotives. Two months ago I bought these same engines for $50,000 each. I have a contract here which the United States has already approved. I am certain that you will be making a good profit on this contract at the price I suggest."

And then he presented the contract, which was signed by the manufacturer.

On this one purchase alone the United States was saved many million dollars, and the man who saved the money is receiving one hundred cents every 365 days.

EDISON AND THE SUBMARINES.

One afternoon at two o'clock Mr. Edison called at the White House and asked to see President Wilson. At three minutes after two the great inventor was in Mr. Wilson's personal study in the residential wing of the executive mansion. By two-thirty the conference was concluded and the President himself made an appointment for Mr. Edison with Secretary of the Navy Daniels. That afternoon a new anti-submarine device was explained to a selected board of naval officers. The navy was as quickly convinced as was the President, and by seven o'clock the next morning Mr. Edison and a naval staff, aboard an American warship off the Atlantic Coast, were testing the invention on an American submarine, which was previously instructed to attempt to sink the ship!

So successful were the tests—it is not compatible with public safety to reveal the nature of the scheme—that within thirty hours after the invention was explained to President Wilson it was officially adopted by the American Government.

THE CHINOOK

The little town of Casper, Wyo., reported a curious experience a few days ago. It got out of bed to find the mercury 4 below zero. At 4 in the afternoon the temperature was only a few degrees higher, but at 6 o'clock the mercury had jumped to 60 above zero. This sudden change was due to what the people of the mountain country call the "chinook." The chinook is a hot dry wind that occasionally visits communities in Montana and Wyoming, licking up the snow in front of it like a blast from a furnace. Its effects seemed miraculous to the Indians and the early white settlers. But investigators long ago discovered the explanation. The chinook usually occurs on the eastern slope of a mountain range. An air current blowing over the west slope expands and cools as it rises toward the mountain summit, and precipitates in snow most of its moisture. When it begins rushing down the eastern slope it is exceedingly dry and it warms rapidly by compression. On account of its lack of moisture it rapidly dries the ground over which it passes. These winds sometimes persist for days in the Alps and everything becomes so dry that precautions have to be taken against fires. In Europe the chinook is called the foehn. Before the development of weather science the hot dry air that poured down the Alpine slopes was supposed to have come from the Desert of Sahara. Now it is known to be no different from the phenomenon that meets every boy who pumps up a bicycle tire and discovers that compressed air is warm.

[The above we reprint from the Kansas City Star. The explanation of the phenomenon described cannot be regarded as satisfactory in so far as the rise of temperature is attributed to the compression of the air, since the actual compression is comparatively so slight.]

PRECOOLING VENTILATING AIR FOR ELECTRIC GENERATORS

BY JOSEPH T. FOSTER.

The question of whether to install air washers or humidifiers for conditioning and cooling the air entering generators is particularly pertinent at this time, since by cooling this air the generator capacity may be increased from 10 to 20 per cent. Furthermore, by cleaning the air possible shut-downs for generator cleaning and, what is more serious, possible burn-outs due to heavily loaded, dirty machines, may be avoided. Obviously, then, this is the quickest and cheapest method of increasing power plant capacity, and as electric companies are at this time confronted with long deliveries, delayed shipments due to present transportation conditions and labor shortages, this subject should receive special attention now.

The purpose of central station companies in including the air washer as standard equipment on turbo-generator installations is twofold:

1. For supplying clean air, free from dust which would coat the windings of the generator and form an insulating covering.

2. For precooling the air by evaporation of water when the air passes through the film of water atomized by the spray nozzles.

Before air-washing equipment was used it was found that the dust and dirt incidental to the unloading of coal and the disposal of ashes fouled the generator by coating the air passages. It was therefore necessary to shut down the generator at least once a year for a period of five or six days for cleaning purposes. In addition to the expense of cleaning there was the inconvenience and loss of revenue due to shutting down the unit.

Some idea of the cleansing effected by a modern-type air washer can be gained from tests which showed that it was possible to blow several pounds of soot per minute into the intake and have the air at the generator inlet perfectly free from dust.

There is a more or less widespread belief that the humidifying of the air increases its cooling capacity on the ground that wet air, on account of its higher specific heat, has greater heat-absorbing properties. The effect of this change in specific heat is negligible as far as heat absorption is concerned, because the weight of water vapor present even in saturated air is very small as compared with the weight of the air itself. The difference in the amount of heat absorbed by saturated air as compared with dry air under a given set of conditions is not more than 1 or 2 per cent.

The precooling action of the air washer is, however, of importance. Assume a 12-500-kva. unit which requires 30,000 cu. ft. (850 cu. m.) of cooling air per minute and in which the losses amount to approximately 300 kw. at full load. The heat aborbed per hour, assuming a final temperature of 100 deg. Fahr. (37.8 deg. C.), neglecting the moisture in the air, will be as follows:

I. Air not precooled and entering the generator at 68 deg. Fahr., $0.24 \times 0.07524 \times 1{,}800{,}000\ (100-68) = 1{,}040{,}000$ B.t.u.'s per hour.

II. Air originally at 68 deg. Fahr., but cooled in the washer to 53 deg. Fahr., $0.24 \times 0.07788 \times 1{,}800{,}000\ (100-53) = 1{,}580{,}000$ B.t.u.'s per hour.

In the first case, the losses absorbed amount to 1,040,000 B.t.u.'s per hour, or 305 kw.; in the second to 1,580,000 B.t.u.'s per hour, or 463 kw. It may be assumed with fair accuracy that the losses are proportional to the squares of the currents; therefore, $I_2^2/I_1^2 = 463/305$, or $I_2 = 1.23 I_1$. The terminal voltage is, of course, constant, hence the kilowatt output when the air is precooled will be theoretically 23 per cent greater than with air at the higher temperature. It is more probable, however, that in

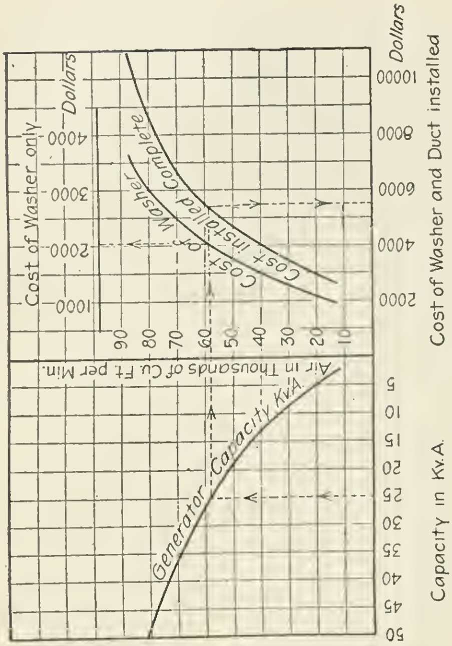


FIG. 1

practice the gain under the conditions stated would amount to 15 per cent, although gains of 20 to 25 per cent have been realized even where the natural conditions were particularly adverse.

The gain in generating capacity obtained by precooling the ventilating air is large, but is obtained by the expenditure of a comparatively small amount of money, as shown in Fig. 1.

The use of the chart is illustrated by the following:

Problem.—Given a 25,000-kva. generator, to find the amount of cooling air required, the cost of the air washer and the cost of the washer installed in place.

Solution.—From the intersection of the vertical line through 25,000 kva. and the curve, run horizontally to the vertical scale. The required air is 58,000 cu. ft. (1640 cu. m.) per minute. Running horizontally to the intersection with the first curve, read on the upper scale the cost of the air washer as $2,050. Running horizontally to the second curve, read on the lower scale $5,500 as the cost of the complete installation.

An illustration of an air-washer installation used in connection with a turbine plant is shown in Fig. 2. The air, which is drawn through louvers and screens at the left, passes through the washer and then through the generator, from which it is discharged direct to the forced-draft blowers in the boiler-house basement.

This method of operation is employed during summer weather when it is desired to obtain the coolest air possible for the generator. The discharge to the forced-draft blowers of this quantity of heated air improves the boiler efficiency somewhat and maintains a lower turbine-room temperature.

Under winter conditions the louver opening in the outside wall is closed by a rolling door and the air is drawn into the washer from the turbine room through the side door and discharged from the generator bypass through the sliding door provided for that purpose. Under these conditions the door into the boiler-room basement is closed.

This method of recirculating the air from

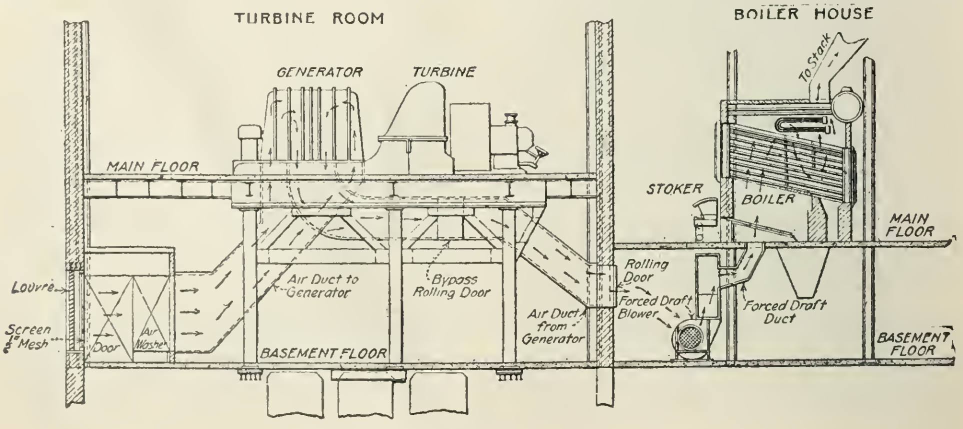
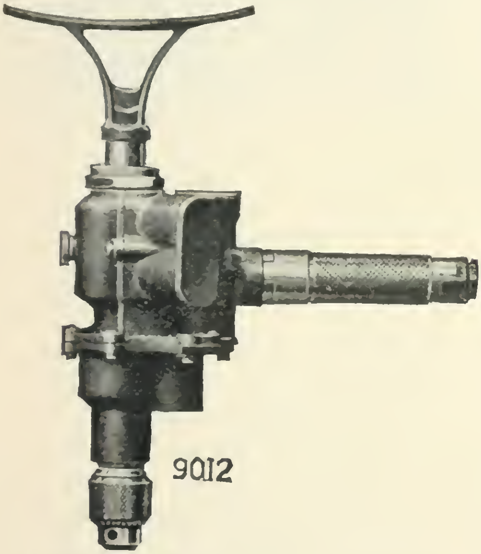


FIG. 2

the turbine room keeps the room at a comfortable temperature. It also does away with the inconvenience of having a partial vacuum in the turbine room due to the removal of large quantities of air from an inclosed space.

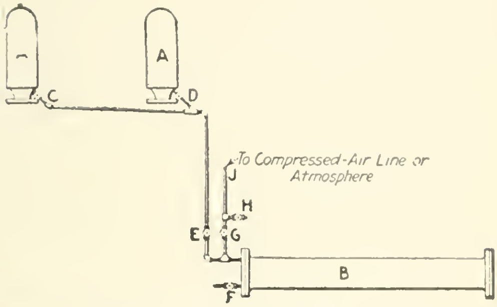
The washer to be purchased by the engineer should be of the size specified or recommended by the generator manufacturer, of the heaviest and most durable material, and able to cool the air to at least 85 per cent of the difference between the wet and dry bulbs. At the same time the air resistance through the washer should not exceed 0.375 in. (9.3 mm.) of water and the power consumption should be kept down to a minimum.—*Electrical World.*



A LIGHT AIR DRIVEN ROTATING DRILL

The Ingersoll-Rand Company has added to its line of "Little David" pneumatic tools a new light-weight, high-power, non-reversible drill especially adapted to that class of drilling and reaming work which may come within its capacity limits of reaming up to 5/16 in. and drilling up to 9/16 in. This new drill has been designated No. 5 "Little David." It weighs 15 lb. and develops a free spindle speed of 1000 r.p.m. With drill chuck its over-all length is 14⅝ in. and the distance from side of drill to center of spindle is but 1½ in., which facilitates its operation in unhandy places. The spindle is threaded to accommodate either a No. 1 M.T. socket or drill chuck, and these may be readily interchanged as desired.

The four-piston motor is very simple and the convenient accessibility of the reciprocating parts is pointed out to be of advantage. It is stated that the removal of five caps screws permits the crankshaft assembly to be withdrawn in its entirety. The valve is of the rotary type and is gear driven. Roller bearings are used on the connecting-rods and ball bearings on the crankshaft. The No. 5 "Little David" may be had with either breast plate spade handle or telescoping feed screw. In the latter case the length of feed measures 2½ inches.



FILLING AIR CHAMBERS

TO FILL PUMP AIR CHAMBERS WITH HIGH PRESSURE AIR

BY W. A. MC CURDY.

Following is a description of a scheme which is simple and inexpensive, but which works wonders on pumps operating against high heads, by filling the air chambers with air at a pressure equal to that due to the hydraulic head. This device is not new, but is of value.

IMPORTANCE OF THE AIR CUSHION.

When we stop to think that a cylindrical air chamber 30 in. long, filled with air at atmospheric pressure, will have but the top one inch of its length full of air when working under a 1000-ft. head, it is evident that the air chamber is of no use, while with this same chamber full of air at the proper pressure, there is a perfect cushion to absorb the shock due to the sudden thrust of the pump plunger against the end of a long, heavy column of incompressible liquid.

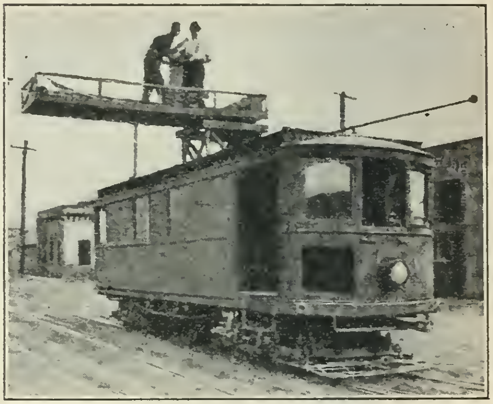
HOW IT ACTUALLY WORKED.

There are in the mines of the Oliver Iron Mining Co. on the Vermilion Range several crank and flywheel pumps of about 1000 gal. per min. capacity, operating against a head of approximately 1000 ft. A speed of 38 to 40 r.p.m. was about the limit of safety prior to the installation of this device. On account of the heavy water-hammer, it was impossible at higher speeds to prevent gaskets from blowing out, fittings from breaking and undue wear and tear due to the excessive vibration of everything connected with the pumping plant. With this device in use, the same pumps can now be operated at 55 to 60 r.p.m. as noiselessly and smoothly as a new sewing machine. In other words, the pumps may be run right up to capacity without difficulties of any sort.

Referring to the attached sketch, the device consists of a length of heavy pipe *B* which may be 8, 10 or 12 in. in diameter and 16 or 18 ft. long, the ends being closed with blind flanges. One flange is drilled and tapped near the bottom for a 1½-in. pipe which will drain the large pipe, and near the top for a 1-in. pipe. From the 1-in. opening pipes lead to the air chambers *AA* and to the compressed air line or atmosphere through *J*. There are 1-in. globe valves suitable for the high pressure at *C, D, E, G, H* and *I*. At *F* is a 1½-in. valve. The pipe *B* should be level and the 1-in. pipe *CDE* should be continuously up-grade from *B*. There should be no point in this pipe as high as the point *C*, otherwise the air will be trapped and cause the device to operate slowly or not at all.

Operation is as follows: Valves *C, D* and *H* are open. Valves *E, G, F* and *I* are closed. Now open *F, G* and *H* or *F, G* and *I*. This will drain or blow all water out of *B*. When *B* is empty, close *F* and *H*, leaving *G* and *I* open till *B* is filled with compressed air at 60 to 75 lb. pressure or with atmospheric air if there is no compressed air handy. Now close *G* and *I* and open *E*. Water will now flow from *AA* to *B* compressing the air in *B* to pump pressure, after which this air will bubble up through pipe *EDC* to the air chambers *AA*. After a few minutes close *E*, open *F* and *G* and repeat operation till air chambers are full of air. This will be known when the valve *F* discharges air instead of water. Two of these operations are sufficient for the pump previously mentioned. It might be well to have a trycock in one air chamber just above where *C* or *D* enters.

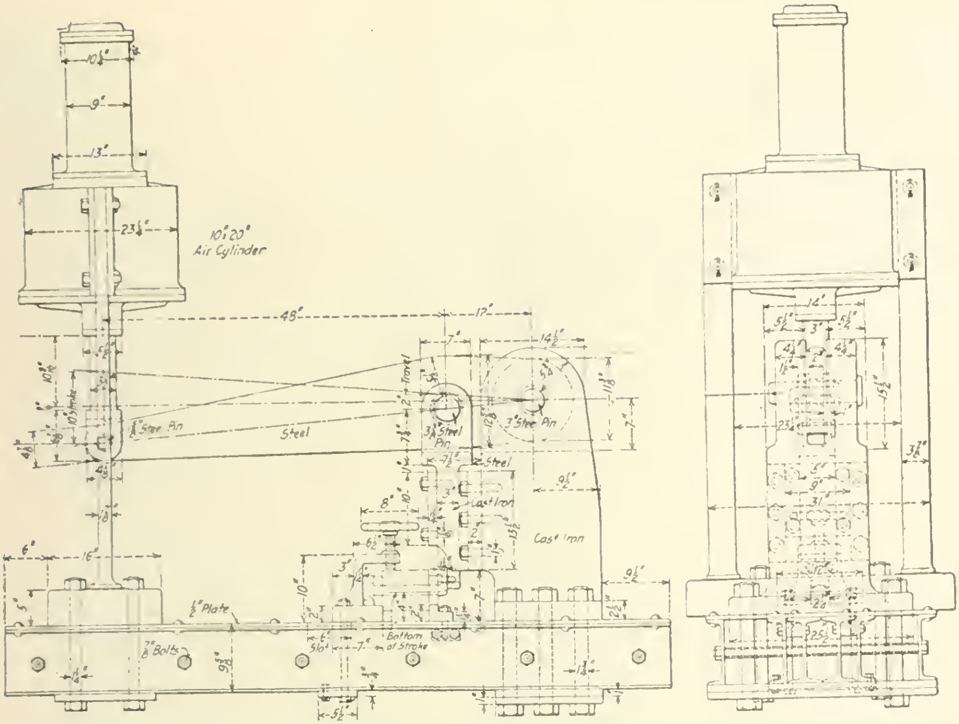
The valves *H* and *I* are not necessary when air is taken from the atmosphere. They are merely a safeguard against water entering the compressed-air system when the device is idle. To prevent this *H* is left open to drain off any water leaking by *G*. Doubtless the device can be still further simplified and improved—*Eng. and Mining Journal.*



AIR ELEVATED WORKING PLATFORM

The half-tone here reproduced from a recent issue of Electric Railway Journal shows a compressed air operated device which will be easily understood and at once appreciated. This is a line repair car operated by the Washington Water Power Company, Spokane, Wash., the working platform of which is raised and sustained by compressed air, the air always ready in the air brake system. There is a vertical cylinder 10 in. dia. and 7 ft. long firmly secured in permanent position in the car, and in this is a piston or plunger to which the platform is attached. The working height desired is immediately adjusted by the manipulation of a valve at either end of the car. There are by-pass ports which prevent overtravel in the lift, and roller bearings permit easy rotation all around the circle. The air pressure will hold the platform with two men working on it for twenty minutes, but independently of that means of locking are provided when longer periods of work occur. The working platform, 14 ft. by 4 ft., is locked lengthwise of the car when not in use. The entire roof of the car is planked so that the crew can use it for working purposes.

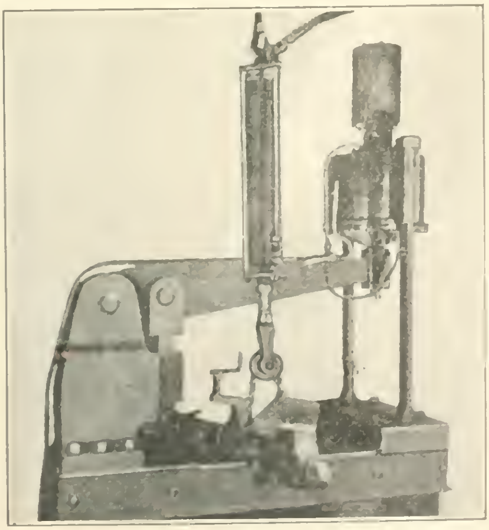
In the midst of a war that will be won by steel wrought into ships and shells, the American steel industry, grown into giant stature, produced in 1917 nearly three tons to every two tons in the rest of the world.—*Iron Age.*



PNEUMATIC RIVET SHEARING MACHINE

BY E. A. MURRAY.*

The device for shearing coupler yoke rivets shown in the illustration can be made at slight expense and, it being easily portable, it enables the yoke rivets to be cut at any point where compressed air is available. The saving effected by eliminating the necessity of carrying coupler yokes to the shear is quite considerable. The base of the machine consists of two 9-in. I-beams and four 9-in. channels to which are riveted two ½-in. steel plates. At one end of this frame is placed a yoke which carries two air cylinders, the upper one of which serves as a dash pot. The lower one is 20 in. in diameter and the upper 7¾ in. At the other end of the frame is bolted a heavy casting which serves as a fulcrum for the steel arm which carries the shear and shear blade. Directly under the shear blade is bolted a block which serves as a support for the coupler yoke when the rivets are being cut, the other side of the yoke being held up at the same time by a movable bracket to which is attached a hand-wheel, which is attached to a screw. By tightening this screw after the coupler is in posi-



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*Master Mechanic, Chesapeake & Ohio, Clifton Forge, Va.

tion, it is impossible for the coupler to turn when the shear blade comes down upon it. The arm to which the shear blade is attached is of steel. It has a travel of 2 in. and is guided by a slotted casting, bolted to the fulcrum casting. The lever, which is attached to the cylinder is of steel, the proportions being such that a leverage of five to one is obtained on the shear. A lateral movement for the pins in the piston rod and the shear arm is provided for by slotting the holes in the lever. The air to the machine is controlled by the 3-way valve shown just below the large cylinder and at the left. A coupler is shown in position for shearing, suspended by an air hoist in the middle of the picture.—*Railway Mechanical Engineer.*

ECONOMY OF COMPRESSED AIR FOR STREET SURFACE OPENINGS

BY H. L. HICKS.

The labor problem in municipal work, as in other fields of construction and maintenance, is calling for increased effort to replace men, who cannot be had, with machinery. For certain phases of the work pneumatic drills and kindred tools have proven their worth. Such drills as the Jackhamer, a 40-lb. self-rotating hand hammer drill, have taken almost entire possession of the field of rock removal in municipal contracting. It is but natural that, as contractors came to appreciate the handiness of a tool, they should begin to think of jobs, other than rock drilling, that could be done to better advantage by its use.

The removal of asphalt, concrete or block paving in opening streets for the laying of water, gas or sewer piping, electric conduits, etc., has been, by hand work, a relatively expensive job. By applying air tools the cost has been lessened, the work speeded up and better results obtained.

REMOVING CONCRETE PAVING.

In Des Moines, Iowa, electric service lines were to be laid in underground conduit. By hand methods it had been necessary to remove whole panels of concrete paving, in spite of the fact that a narrow trench was all that was needed.

The engineer introduced the jackhamer and it was demonstrated that by using the air drill it was possible to restrict the cutting to a strip about a foot in width; a decided saving in the amount of pavement torn up. Hand work would have cost about 40 cts. per foot. With the introduction of two drills and an electric portable compressor it was estimated that the figure could be cut to 30 cts., but actual results showed a cost of 18 cts. per foot.

REMOVING CONCRETE WITHOUT BLASTING.

In cutting concrete, under such conditions as in the subway construction in New York City, where the problem has been merely to tear out paving, foundations and other concrete without blasting, it is common practice to use a pointed chisel rather than the usual rock drill bit. As the rotation of the steel is unnecessary, shanks are made round instead of hexagonal. This, of course, renders the automatic steel rotating action of the drill superfluous. The chisel bit is very effective where concrete is of 3 or 4-in. thickness, as it permits the wedging and breaking off of relatively large chunks.

The problem of concrete pavement cutting has led to the adaptation of other air tools to the work. On part of the subway work, above mentioned, a heavy riveting hammer, when fitted with suitable chisel, was found an excellent pneumatic pick. In other cases the pneumatic tie tamper has been fitted with a sharpened pick and developed into a conveniently handled concrete remover. In removing concrete pavement preparatory to replacing the rails of a Chicago street railway a strip 6 to 8 in. wide was torn out at a rate of 30 ft. per man per hour. Average performance reports indicate that pneumatic equipment will better the working speed of a gang of twice as many men using hand picks.

REMOVING ASPHALT PAVING.

Somewhat akin to concrete removal is the taking up of asphalt paving. For this service the tie tamper is a time and labor saver. A flat chisel of about 3 in. width is used. First the pavement is scored with the tool in an inclined position. . Then it is held upright and the paving cut through and pried up. This method of applying tie tampers was developed by the street railways and shows such excellent saving that it will be undoubtedly applied by municipal contractors to similar work. At Elmira, N. Y., four men removed approximately 600 sq. ft. per hour, at a fraction of the cost of hand work.

Another tool also used for the same work is a smaller hand pick. With this tool narrow grooves are cut, marking the portion of the asphalt to be removed, at an average rate of 20 lin. ft. per hour.

REMOVING BITULITHIC PAVING.

Bitulithic pavement, being softer and of somewhat sticky nature, is removed in a slightly different manner. A chisel some 1½ or 2 in. in width is employed to make a series of cuts, each the width of the chisel and spaced about 2 in. apart. Cuts of just sufficient depth to mark a distinct cleavage line are made on one side and the ends; the pavement is cut through on the remaining side, a crowbar is slipper under and the block or slab of pavement pried out. At Portland, Oregon, pavement of this kind was removed in slabs 4-ft.x4½ ft. at a cost of 49 cts. per square yard.

REMOVING BLOCK PAVEMENT.

In tearing up block pavement any of the tools can be used, although a hand hammer is most useful when it comes to toothing out the edges of the section removed or cleaning used blocks of the adhering binder. With the introduction of air hammers a marked reduction in the breakage of blocks is to be noted. In one city where air tools are used it was found that a five-man gang using two hammers removed and cleaned 2,000 paving bricks in an 8-hour day—as compared with 1,000 brick for 10 men working by hand.

Entirely aside from the benefits derived from reduced cost of working is the improvement in public relations resultant from the shortened elapsed time during which streets are closed to traffic.

GUN FOR DIGGING SLAG

The half-tone shows in use a "gun" for loosening slag from open hearth slag pockets recently placed on the market by the Rivet Gun Cutting Company, Cincinnati. By the use of this tool skilled labor is dispensed with and the labor cost is reduced. By its use the operator strikes a blow many times harder than is possible with a sledge, and the blows are repeated fifty times as fast.

There is an eight pound piston with a twenty-six inch stroke operated by compressed air, which may give an idea of the force of the blow. The air is controlled by a three way valve and the blows may be heavy or light and slow or rapid as desired. The force of the blow is cushioned by patented devices, so that the tool has no self destructive features and it does not "kick the operator." It is extremely simple and does not get out of order. The usual shop air pressure of 60 to 80 pounds gives the best results.

PROPOSED SPECIFICATIONS FOR AIR LINE HOSE FOR PNEUMATIC TOOLS

At the last annual meeting of the American Society for Testing Material a committee report was submitted containing tentative specifications for air line hose for pneumatic tools. The specifications cover wrapped air line hose suitable for air tools working at not more than 125 lb. pressure and for vacuum outfits. Extracts from the specifications follow:

The hose shall consist of: (a) An inner rubber tube; (b) cotton reinforcement; (c) an outer rubber cover; (d) when specified, an extra covering of cotton wire.

The rubber tube shall be smooth, uniform in quality and thickness, and free from injurious defects.

The reinforcement shall consist of cotton canvas plies made from duck evenly and firmly woven from good cotton, as free from unsightly defects, dirt, lumps, knots and irregularities of twist as is consistent with the best manufacturing practice. It shall be well frictioned on both sides with a rubber compound suitable for the required service. The plies shall be laid on the bias and be sufficiently strong to enable the hose to successfully withstand the hydrostatic pressure test; yet at the same time be soft and pliable.

The rubber cover shall be uniform in quality and thickness and be free from injurious defects.

When specified, the hose shall be given an extra covering of one of the following, as specified: (a) An armor of half-round wire 7/32 by 5/64 in. spaced ¼ in. part; (b) canvas; (c) cotton braid.

Unless otherwise specified, the hose shall be furnished in 50-ft. lengths. The ends of each length shall be uncapped and without fittings.

The mimimum tube and cover thickness shall be as follows:

Size in.	Minimum Tube Thickness. in.	Minimum Cover Thickness. in.
⅜	1/16	3/64
½	1/16	3/64
⅝	1/16	3/64
¾	3/32	1/16
1	3/32	1/16
1¼	3/32	1/16

TREACHEROUS MINE-GAS MIXTURE

"Yes," said the mine boss to the master mechanic, "you probably have the hardest job in the world; but one thing is true, you don't have to contend with gas except what is generated in the shop by some of your able imitators."

"Oh, I don't know," replied the master mechanic. "I have noticed we never have to speed up the fan when you are down in the mine. You always seem to carry plenty of breeze along with you."

"Maybe," answered the mine boss, "but I can recollect two or three times when I wished my lungs were air compressors. Did I ever tell you about the time I set off the fireworks for the ladies?"

"I expect you have," replied the master mechanic, "but the story will be so much different this time that I probably won't recognize it, so go ahead."

"I do have to stretch them sometimes," returned the mine boss, laughing, "to keep from being completely outclassed, but this is a true story."

"When we were driving old No. 1, we ran into a fault where the coal pinched down for a distance of 60 ft. or so, and like most faults in this mine, the seam carried a small amount of gas. There was not enough of it to require using safety lamps, and it was customary for the miners when they started work in the morning to blow it about a bit with their coats and then set it off. The flame would sweep back a foot or so from the roof for maybe 20 ft. from the face, which was all there was to it. The men could then put in their shift without any more trouble.

"Well, one Sunday the 'Old Man' came out with some of his friends who had never seen a mine, and wanted to show them around. There was the boss and his wife, this gentleman and his wife and their daughter, a young lady about twenty."

"We now come to the point of the story," interrupted the master mechanic. "Brave Mine Boss Saves Beautiful Heiress from the Flames. Undying gratitude. Generous reward. Raise in salary. Yep, I see it all."

"You see nothing, as usual," replied the mine boss, testily. "This is what really happened. I took the party down and showed them the workings. We went part way up in No. 1, and the boss, who knew how we were working the gas, thought it would be interesting to show how we burnt it out. I didn't like the idea very much, but I agreed; and while the rest of them waited back down the entry, I went up to light it off.

"Well, sir, there must have been a little more than usual, because before I got to where we ordinarily lit it, away she went; and the first thing I knew I was flat on the bottom, wallowing in a puddle of mud. In the excitement all the lights went out, and the women were yelling and scrambling in the dark down the gangway.

"Old Jake Crosby, who was master mechanic at that time, was along, and I hollered to him to light up. He didn't answer, but as I got up I saw somebody coming from 'way down the entry. It was old Jake. And I bet he must have run 50 yd. in 4 sec. He came hurrying up all excited and shouting, 'Is everybody all right! Is everybody all right!'

"No damage was done except that I ruined a good suit and got a nice hair singe free; but believe me, I learned a lesson right there. Never again. I wouldn't even light a gas jet now for the Queen of Sheba!"—*Coal Age.*

EXPLOSIVE MIXTURES IN BOILER FURNACES

BY GILBERT RUTHERFORD.

Probably every one who has operated boilers has at some time encountered the furnace explosion that blows fire doors open and singes the fireman's hair with the hot flame or blows coal particles into his face or eyes. The incident is not uncommon and, although potentially a dangerous occurrence, fortunately in most cases causes only temporary disability. The use of so-called low-grade fuels at this time of coal scarcity and high prices for marketable coal tends to increase the seriousness of furnace explosions. A brief discussion of their cause and prevention, based on the writer's experience, may therefore be of value.

Furnace explosions happen either when the furnace door is opened or when it is closed. The reason for the explosion is the same in both cases, but the manner in which the explosion is brought about is different in the two cases.

Consider an instance where a furnace is incased in a setting that is new and airtight so that air infiltration is eliminated by plastering up cracks and crevices, etc. No air enters above the fuel bed, and the furnace chamber is filled with combustible gases. The fire doors are closed and the furnace is operating, and at fairly low rate of combustion, which means comparatively high draft for a thick fuel bed. The fireman now opens the fire door to throw on some more coal or to look at the fire or rake it over. There being a difference of pressure between the inside and the outside of the furnace chamber, such that the air rushes from the outside to the inside, the air from the boiler room is caused to rush in immediately and mix with the combustible gases above the fire. Combustion occurs instantly and with such rapidity that it has an explosive effect, blowing out the gas and coal into the face of the fireman. The simplest remedy is to maintain balanced pressures, or nearly so, between the inside and outside of the furnace chamber.

Another common cause of explosion is in cases where the furnace doors are closed after being opened. Suppose a fireman throws a shovelful of slack coal—for example, anthracite dust—upon the fire. To prevent cooling the fires he opens the door wide, throws in the coal as quickly as possible and shuts the door again immediately. While the fire door is open the furnace settings fill with air, partially at least. The slack coal thrown on the fire spreads over the fuel bed and combustible gases are distilled. The gases rising from the fire may contain as much as 30 per cent of combustible. This mixes with the air entrained in the setting, the mixture becomes ignited, a small explosion occurs, and the firedoor of the furnace is blown open with considerable force as a consequence.—*Electrical World.*

A GARAGE DANGER

The poisonous character of the fumes arising from a gasoline engine may be appreciated by the following extract from a recently published book: "If a gasoline engine, producing 5 cu. ft. of CO per minute were allowed to run in a tightly-closed garage that was 12 ft. high, 15 ft. long and 15 ft. wide—that is, having a capacity of 2,750 cu. ft.—it could produce an atmosphere, if the latter were thoroughly mixed, containing about 1% CO in about five minutes. This percentage of CO in air is a fatal proportion, and would probably kill a person in less than a minute. In fact, an exposure for as long as 20 minutes to an air containing as little as 0.25% CO would make most people very ill."

FOR MACHINE DRILL SHARPENERS

For many years machine or power sharpeners have been used at mines, but contractors have been rather slow in adopting machine sharpeners except where a large number of drills were in use. The labor cost of sharpening bits with a machine sharpener averages about one-third the labor cost of hand sharpening (see Gillette's Handbook of Rock Excavation, p. 56, etc.), and the total cost is about half as much for machine work as for hand work. But this is not the only economic advantage, for machine sharpened bits require less frequent sharpening and the drilling speed is often 15 per cent greater than where hand-sharpened bits are used. A machine operated by one man can repoint 60 bits an hour, and the bits are perfectly uniform. Even where there are so few drills that a drill sharpening machine cannot be kept busy, it pays to own one.—*Engineering and Contracting.*

LEARNING THE GAS MASKS

The "Little Green Door" behind which lies the gas chamber to accustom soldiers to German vapors had an extraordinary fascination for American troops to-day.

A steady stream of queer, gnomelike, olive drab clad boys passed through the door to-day, all with masks firmly adjusted, and emerged plainly tickled at the unique experience. The entire first contingent is being schooled in the gas chamber.

One youngster from New York city, whose comrades had kidded him about the deadly effects of the gas and the terrible perils of the test, fainted twice before he underwent the ordeal. Then in true soldier fashion he took a brace on his nerve and went through without a quiver.

The "Little Green Door" is the entrance to a sort of cave dug in the hillsides, its roof supported by timbers, the whole covered with sod and sandbags. A personal experience with the test proves it is a spooky stunt and as hot as a Turkish bath. Not a trace of gas penetrated the masks of any of the American soldiers.—*Daily paper.*

E. C. Drew has been serving a six-year sentence in the federal prison at Atlanta, convicted of using the mails to defraud. He sold stock in a company which proposed to drill for oil near Cordova, Louisiana. Recently a well was opened on the ground with a good flow of oil, notwithstanding the fact that experts had testified at the trial that there could be none there. It is merely a little story of the chances of life; but what is the answer? Is Mr. Drew not entitled to some compensation for the ruining of his life by government "experts" who knew no more about the matter than the man in the moon?—*Salt Lake Mining Review.*

The Tech of Boston tells of an individual heating apparatus for soldiers which Colonel Robert L. Howze is now testing to determine its practicability. The heater is not larger than a canteen and it is claimed that it will keep hot for 36 hours and can then be recharged for another period. The heater is filled with a chemical fluid which is first heated by immersion in boiling water. The chemical action increases the heat to a high degree and maintains it for 36 hours. A new charge is a chemical substance no larger than a pea. The "stove" and fuel may thus be carried by a soldier in his haversack.

The Oakland industrial appliance department of the Pacific Gas & Electric Company has made some demonstrations in cutting iron with fuel gas and oxygen. A special torch is used whereby a hot flame cuts its way through the iron. A plate of iron 30 in. wide and an inch thick was cut in two in two minutes and fifty-five seconds, using 3.25 cu. ft. of fuel gas and 6 cu. ft. of oxygen. Acetylene was used, taking 3 lb. and 6.5 cu. ft. of oxygen to do the same work. Fuel gas makes a saving of about 50 cents per day in a large shop doing continuous cutting.

At a recent joint meeting of representatives of the Institute of Bankers, the Association of Chambers of Commerce, and the Decimal Association, unanimous agreement was reached on a plan for decimalising the coinage with the present pound sterling as the unit. The scheme was brought before the council of the Association of Chambers of Commerce this week, and unanimously approved, a further resolution being carried to press the need for this reform, through the Chambers of Commerce in all parts of the United Kingdom.

For the eighth time since 1844 fish have been killed along the west coast of Florida in an area of poisoned water. Not only the water, but the air has been charged with a suffocating gas, odorless but irritating to the air-passages. The last mortality was reported in October and November of 1916. The Bureau of Fisheries sent experts to the spot but they were obliged to admit, after a careful investigation, that the cause of the strange occurrence is a mystery.

Before the war, if an aeroplane was provided with one horse-power for every 28 lb. of weight, it was considered capable enough for use over the battle lines. Now the fast scouting machines may have this amount of power for every 8 lb. or 10 lb. of weight, and even less.

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ELECTRICITY AND COMPRESSED AIR AS COAL SAVERS

In these days, when the thought of the general public is compulsorily directed to the saving of fuel, it is quite pertinent to call attention to the agencies which are both potentially and actively most efficient for the purpose. It may cause some surprise to the thoughtless that any claim should be made for the electric industries as commendable economists, but the fact that they use large quantities of fuel does not necessarily imply that the fuel is used wastefully. In fact the fuel operated plants of the large electric companies are monitors to the world of the ultimate, up to date possibilities in economical operation, the economies permeating every detail, the combustion of the fuel, the generation of the steam, its distribution and employment in the development of motive power, and then the consistent economies in the generation and distribution of the electric current. In the profuse and reckless use of electric light there may be undoubtedly great waste, which very properly should be stopped, at least under the present exigencies, but that is another matter.

But the surprising thing is that of the enormous employment of the electric current for every purpose, for light, heat and power, by far the larger portion of it is accomplished without the consumption of fuel at all. It is reliably stated that of the 650,000,000 tons of coal which will be mined this year in the United States only 4 per cent. represents the entire electric central station requirements of the country, the greater part of the electrical energy now used being generated in hydro-electric stations. In a general way every one knows this. The central station which employs water power for the generation of electric current is not to be regarded as a mere saver of fuel, but rather as an actual and most important contributor to the coal pile of the nation, and every available water power, whether at present utilized or not, is the equivalent of a coal mine, with the unique feature added that the mine cannot be exhausted.

In the wide employment of the electric current for power purposes, whether it be generated in the economically steam operated central stations of some of the larger cities, or in the more numerous and the more universally distributed water power utilizations, compressed air is an important cooperator. It is to be said generally of the use of compressed air that where it is not indeed the only mechanical agency which can be successfully employed for the specific purpose, it is still in almost every case a time or labor saver and therefore intrinsically economical, and where the compressor is electrically driven there is a largely increased effect as compared with the power cost. The fuel saving idea, which has been brought to the front by the exigencies of the war, has really nothing of novelty about it. The larger engineering contractors, in their quest of the larger profits, have made a systematic study of it, and accordingly we find the electric driven air compressor in use wherever the modern enterprises are successfully conducted. We are not at present in position to submit actual data, but the number of electric driven compressors is quite astonishing and rapidly increasing.

IMPORTANT WORK OF THE NAVAL CONSULTING BOARD

The Annual Report of the Secretary of the Navy for the year, 1917, speaks in terms of high appreciation of "the able and helpful Naval Consulting Board."

"The Naval Consulting Board," it says, "has been found very useful, not only in assisting in the solution of military problems but in dealing with the immense flood of inventions and ideas submitted to the department from the country at large. It is true that a majority of these are not found to be of practical value, but it is a fact that practically all of them are submitted with the patriotic motive of helping win the war, and the department has felt that they are all entitled to serious and appreciative consideration."

The following is the complete text of the report upon this topic:

THE NAVAL CONSULTING BOARD.

During the year the work of this board, organized and approved by Congress in 1915, has increased very materially in importance and volume, its meetings have been frequent and the work of its individual members has been such in some cases as to occupy almost their entire time in the service of the Government.

Some time before the active entry of this country into war the board called a special meeting to which were invited some fifty of the leading scientists and industrial managers, whose special study fitted them to advise on the methods of meeting the submarine problem. Plans were immediately made to investigate every field to develop a means of preventing destruction of vessels and of defeating the U-boat. The investigation was divided according to the experience of the different members and associated scientists, and, with the cooperation and valuable assistance of the various manufacturing companies interested, a highly developed system of team-work has been attained and results accomplished not dreamed of at the beginning of the war.

The services of the board were offered to the Council of National Defense and accepted by that body for the investigation of all inventions submitted. Its services were also accepted by the War Department in an advisory capacity.

Valuable assistance has been rendered merchant shipping by the board's activities. Through its initiative, counsel and work, the United States Shipping Board formed its ship-protection committee, taking over the study of the protection of merchant ships, and to this committee was detailed one of the Consulting Board's most experienced members qualified in shipbuilding and with sea experience. In this field the board's work has resulted in materially reducing the shipping risk, with a consequent lowering of marine insurance rates.

Not the least result of its work has been the stimulation of interest, in the problems brought up by the war, throughout the country by the general invitation to submit ideas for investigation. Early in the calendar year 1917 this interest manifested itself in the receipt of thousands of ideas weekly, and to care for this the department's connecting office has been greatly enlarged, the office of the board in New York has been organized on a working basis with a large force, and the whole movement has received the approval and hearty assistance of the great national engineering societies. The president of the board, Mr. Thomas A. Edison, has been giving his entire time to the work of the board in the service of his country, and has called to his assistance a capable staff who are working diligently upon naval problems.

With war conditions increasing the need for labor and building materials, it was believed to be a wise policy to defer for a time the building of the new experimental and research laboratory. Such experiments as have been warranted have been made in private laboratories, generously offered, and at the Bureau of Standards. The need for this establishment, however, is more clearly shown than ever, and its support is urgently advised.

The valuable results obtained by the work of this board are of too confidential a nature to make them the subject of a public document. The members have given freely of their time and scientific ability to the service of the Nation and have earned the gratitude of all who know their unselfish and patriotic service. I wish to express my sense of obligation for the cheerful cooperation, wise counsel, loyal devotion, and personal sacrifice which have characterized the membership of the board of distinguished civilians who responded, long before war was declared, to the selective draft with all the enthusiasm and efficiency of youthful volunteers.

MOUNTING HAMMER DRILLS ON TRIPODS

The following letter to the Editor of *Engineering and Contracting,* with the appended editorial comment, will be found interesting and is sufficiently self-explanatory. It does not seem to be necessary to reproduce the original article here referred to.

To the Editor: In your issue of Nov. 21, page 409, I note an editorial entitled, "Why Are Air Hammer Drills Not Mounted More Commonly on Tripods?"

The suggestions contained in this editorial seem to me to be rather dangerous and are very apt to invite trouble. The modern hammer drill used for down hole work, unlike the reciprocating drill, is of very light construction, weighing not to exceed 40 lb. to 60 lb. A suitable tripod would weigh in the neighborhood of 150 lb. to 200 lb. or from three to four times as much as the drilling machine. The drill used without a tripod requires no helper, whereas mounted on a tripod a helper would have to be provided in order to handle the heavy mounting. There is no real excuse for mounting a 40-lb. machine, as most of them are self-rotating, and the only effort required on the part of the operator is in holding the machine to its work when starting a hole and in changing drill steels, which work would not be eliminated by the use of a tripod. This is irrespective of the depth of the hole.

You refer particularly to the application of a tripod and hammer drill to work in seamy ground. It seems to me the objections to the use of this type of equipment are even more pronounced than under other conditions, as the drilling machine would necessarily be in fixed position, and the tendency of the drill bit to follow a cleavage would put an enormous strain on a comparatively light drilling machine. I am afraid this would lead to all sorts of trouble.

There is another objection to a tripod mounting, and that is the time lost in moving the mounting and readjusting the machine from hole to hole would materially reduce the actual drilling time, materially increasing the cost of drilling per foot of hole. It is not uncommon to find an unmounted hammer drill will put down a reasonable depth hole in the time ordinarily required to move a tripod and reciprocating rock drill.

C. A. Hirschberg,
Publicity Manager, Ingersoll-Rand Co.,
New York.

[The editorial suggestion in our issue of Nov. 21 was prompted by the fact that 40-lb. hammer drills are being successfully used on quarry bars and tripods in two quarries of the Knoxville, Tenn., marble district. The Appalachian Marble Co., for example, has displaced 6 piston drills with 4 air hammer drills (40-lb.), and only 5 men are needed to operate the 4 hammer drills as against 12 men formerly required on the 6 piston drills. Hammer drills are mounted in pairs on a quarry bar 10 ft. long. Drill holes are 14 ft. deep and 1½ in. diameter at the top 1 1/16 in. at the bottom. The holes are close spaced, which enables the drilling of several holes from one setting of the quarry bar.—*Editor Engineering and Contracting.*

NEW BOOKS

The Modern Gasoline Automobile, its Design, Construction, Operation and Maintenance. By Victor W. Page, M. E., New York. The Norman W. Henley Publishing Company, 1032 pages, 5½ by 8½ in. Nearly 1000 illustrations, 13 folding plates, $3.00, net.

This is a seventh edition of a successful standard work, but is much more than this statement would usually imply. The entire work has been thoroughly revised and corrected and much supplementary matter has been added. Many entirely new topics have come up and have received adequate treatment so that the work is entirely up to date. The book in previous editions has been adopted as a text book in various institutions, for which service it is now better adapted than ever, while it appeals also to the great public now so intimately in touch with the supreme modern means of locomotion.

AVIATION ENGINES, Design, Construction, Operation and Repair. By First Lieut. Victor W. Page, New York. The Norman W. Henley Publishing Company, 589 pages, 5½ by 8½ in., 253 cuts, copiously indexed. $3.00, net.

The airplane is now recognized as supreme among the active agencies which are to determine the result of the World-War, and the engine is the heart of it, so that no book could have appeared more opportunely, especially as it is the work of a man of special and extended and up-to-date experience in this line. The matter of the book covers the topic completely and is arranged in logical sequence. The descriptive matter is clear and satisfying and the cuts are pertinent and helpful.

This book has been censored by the U. S. Government and a few pages and portions of pages are necessarily printed blank.

A BOOK NOTICE WORTH PASSING ALONG

The editor of *The Little Journal* casts aside all conventions and confesses to an ambition —to put it in Japanese fashion,—to pull the honorable and august legs of its readers. He has written a book called *Everyman's Chemistry* which is published by Harper & Brothers, New York, for which they charge two dollars. He admits also that he thinks the price rather high. It is a real chemistry book, beginning with general chemistry and proceeding through the general, inorganic and organic fields, but he tried to be good-natured over it. It is aimed at the man who has not studied the science but who sometimes wishes that he knew something of it.—*The Little Journal, Boston.*

DEVELOPMENT OF THE AIR HOIST*

Compressed-air hoists, which are now so extensively used in machine shops, foundries, boiler shops, locomotive shops, railroad repair shops, and in fact, wherever it is necessary to lift any considerable load, were devised in the shops of the Chicago Bridge and Iron Works, South Chicago, in about 1891.

In constructing the hoist a piece of cast-iron pipe was utilized. This was threaded on each end, and caps or heads were affixed: the one at the lower end having a stuffing box through which passed a rod connected to a piston, and designed to be connected by a chain to the object to be raised; while the head on the upper end was provided with means for its attachment to a wheel adapted to move on a track. The air hose was connected to a three-way cock located at the bottom of the cylinder, thus permitting air to be admitted to and exhausted from the latter, or its supply thereto entirely cut off.

A large number of these hoists in varying sizes were used and found to be of great benefit in lifting, and carrying loads to different points. However the workmanship was crude and the escape of air prevented the load from being held for any considerable length of time in its suspended position. Further than this, the piston was permitted unimpeded upward movement, and in consequence, when a light load was being raised and the air turned on too suddenly, the piston would strike and break the upper head. The Chicago Bridge and Iron Works, made no attempt to market this device, but did manufacture a considerable number on special order for those who had seen the hoist in operation.

One of the first concerns to adopt the hoist was the Ames Iron Works, Oswego, N. Y. This was in 1892. The initial introduction was that of a single hoist in their machine shop, and it proved so convenient and valuable as a time and labor-saver, their shops were soon fully equipped. Hoists were later installed in the boiler shop.

The attention of the Pedrick & Ayer Co., Philadelphia, builders of machine tools, being directed to the compressed-air hoist, and they appreciating its merit and the possibility of an

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*Special correspondence *American Machinist.*

extensive sale, began the refinement and manufacture of the hoist on a commercial scale. The cylinders of the hoists for those of the light class were of seamless brass tubing with the bore accurately machined to prevent air leakage. The larger sizes were of the cast-iron pipe construction employed by the Chicago Bridge and Iron Works; but in both instances the workmanship was that of a high-grade machine shop. The Pedrick & Ayer Co. also designed and manufactured belted air compressors, and thus were in a position to supply a complete hoisting outfit. Their connection with machinery dealers and with the railroads was wide, and the pneumatic hoist was quickly taken up by those to whom it was presented. The business of the Pedrick & Ayer Co. was soon discontinued owing to financial difficulties, and the hoist branch taken over by the Q. & C. Co., of Chicago. By it, the hoist was in no way featured, and was sold only as an adjunct to a number of specialties principally used by the railroads.

The first concern to direct its efforts seriously to the perfection of the compressed-air hoist, and to go into the matter in a whole-hearted manner was the Curtis & Co., Mfg. Co., St. Louis, who started the manufacture of hoists in 1893. They established a separate branch in their manufacturing establishment devoted solely to the development, improvement, and manufacture of the hoist, and made rapid strides in its introduction.

The single-acting hoist heretofore described as being crude, is still manufactured, but it is only put to the simplest of uses; for in addition to the liability of fracture of the top head it has the further fault of requiring external force to lower the piston rod after the load has been released.

POSITIVE CONTROL

Where positive control is required, the balanced pressure hoist is by far preferable to the simple hoist. In this construction of hoist, the under or lifting surface of the piston is at all times subject to air pressure, and the upper surface subject to full or no air pressure, as may be desired. As the area of the piston rod passing through the stuffing box makes the effective area of the two sides of the piston unequal, the tendency is to force the latter to the lower end of the cylinder by a force proportionate to the area of the piston rod; therefore on air being exhausted from the upper end of the cylinder, the piston rod with its load is caused to rise with a speed depending on the rapidity with which the air is withdrawn from the upper end of the cylinder. The speed regulation in a hoist of this description is particularly refined, and it is surprising how accurately the load can be raised to almost the slighetst fraction of an inch, making it particularly adaptable for machine-shop use. A load can be sustained for as long a period as thirty minutes without any appreciable drop.

As the quick and economical handling of materials is of vital importance, lifting is now generally performed by the compressed-air hoist instead of by hand. Floor space otherwise congested is kept clear for new work. The time of passing a job from one stage to another is reduced, and a general all-around saving effected.

THE SENTRIES POSTED IN THE SKY

Hardly a train moves within five miles back of the German trenches, or a squadron of men come up for relief, or digging begins on a new series of emplacements but a pair of keen eyes, steadily watching from great observation balloons just behind the Allied front take notice of it. Every movement, every activity, is registered until a schedule of the usual enemy routine is built up and the average amount of motion known. Any departure from this schedule is suspicious. A train running late or with more cars than usual, men in the trenches being relieved too frequently, new roads or emplacements being built too earnestly, give the first hint that "Fritz," across the line, is up to something. A keen balloonist notes any of these changes and at once telephones down to the ground, "An extra train of six cars passed ——— at 10.40." Half a mile farther down the line another pair of eyes reports, "Large convoy moving up to front, range so-and-so." Still a little farther down another suspicious circumstance is noted, until the general staff down below, assembling all these straws, foresees the beginning of a big offensive across the line. Counter measures are taken, batteries directed, convoys and trenches are smashed up, and the enemy's plans thrown askew.

NOTES

Following an investigation of the mine explosion of mine No. 1 of the Yukon Pocahontas Coal Company at Yukon, W. Va., Earl Henry, chief of the State Department of mines, declared that an air short circuit was the cause of the explosion. While repair work was going on a door on the main intake airway was left open. The short circuiting allowed gas to accumulate in other parts of the mine.

Think of coal mines having to shut down for lack of coal! Scores of mines in Central Pennsylvania operate with electric current furnished by the Penn. Central Light and Power Company, and the company officials say that the plant will shut down if coal cannot be procured.

Officials of the Westinghouse Lamp Company of Bloomfield, N. J., have appealed to Federal food authorities for 35 pounds weekly of brown sugar, stating it would be necessary to suspend operations in the company's plant unless the request was granted. It was explained that brown sugar is used in infinitesimal amounts in the manufacture of electric globes.

The Paris *Journal* recently published an admonition to the public to burn gas where it could with the following conclusions, which, however, the American reader must analyze and apply for comparison to his own local conditions: "To burn gas will be to economize our coal production. A thousand kilos of coal distilled in a gas retort equals more than 1,200 kilos burned in a domestic stove, besides which it has produced 500 kilos of coke, 7.1 kilos of benzol, 9 kilos of sulphate of ammoniaque, 10 kilos of heavy oils or carbure, 1 kilo of phenol."

In one recent battle 250,000 18-lb. shells were fired. This means that 2,250 tons of metal were shot through the air in a single engagement. It would take one man 416 years, working 10 hours a day, to make these shells, or 250 men would have to work 20 months on the same task.

The sinking of a concrete cofferdam for the Louisville Gas & Electric Co. was greatly facilitated by enclosing the exterior of the cofferdam with perforated horizontal pipes spaced 6 ft. apart vertically. Water under pressure was delivered to these pipes, and lubricated the surface of the caisson sufficiently to greatly reduce the skin friction.

Dynamite cartridges encased in tin tubes were used successfully in blasting a water supply channel in quicksand at one of the plants of the American Brick Co. The channel is 530 ft. long and extends through a tangle of underbrush. The soil is quicksand and clay. In blasting through the clay, a hole was bored and cartridges pushed down with a stick no tamping being necessary as the water filled the hole.

The atmometer is a porous clay cup filled with water and used for determining the rate of evaporation due to drying power of air. The humidity of the surrounding air is determined by the rate of evaporation of the water, usually for a period of twenty-four hours. The evaporation rate is expressed as cubic centimeters of water evaporated per standard atmometer per hour. The device is used in testing ventilation in buildings, schools, etc.

Some tests were carried out in the Laboratory of the University of California on the water-tightness of plaster "shot" on the dam face with a cement gun. Several plaster slabs, from ⅜ to 1½ in. thick, made at Gem Lake, were tested with water pressures ranging from 700 to 1,600 ft. for several hours, with no moisture coming through the slab. One 1-in. slab held a head of 1,610 ft. for 2½ hours without showing moisture, then the water pressure was raised gradually to 3,400 ft., and the specimen broke in bending, having leaked a little just before breaking.

There is a stretch of railway along the west coast of Ireland where it was formerly not an uncommon occurrance for the trains to be blown from the rails by the winds from the ocean. These disasters are now prevented by the use of an ingenious form of anemometer which rings an alarm bell when the velocity of the wind reaches sixty-five miles an hour. Each station on the line keeps on hand a stock of movable ballast, a ton of which is placed aboard every car arriving at the station after the bell sounds.

Careful attention is being called to powdered coal as an excellent form in which to use lignites or low grade coal generally. Experiments made by the General Electric Company show that coal can be pulverized more cheaply than it can be gasified. The first cost of a plant for drying and pulverizing is less than for a producer gas plant. When thoroughly mixed with a blast of air in correct proportions powdered coal is practically a gaseous fuel, and has most of the advantages of gas or oil fuel under steam boilers.

A new rust-prevention process recommended for small machine parts is an application to the surface of the iron or steel of iron phosphates. After thorough cleaning, the articles are immersed in a bath containing ferric and ferrous phosphates, with a little manganese dioxide, and at boiling-water temperature they are left until hydrogen is no longer given off. The articles are then air-dried, when they may be treated with mineral oil, or painted, japanned, or otherwise finished. As the phosphate surface is attached chemically to the metal, no rust forms even in cracks in the paint.

From measurements of the wind velocity at five different heights up to 258 meters above the ground at the German wireless telegraph station at Nauen, the law is deduced that wind velocities at different heights vary as the fifth roots of the heights. At 512m. the velocity is twice that at 16m. The diurnal variation of wind velocity at the surface with a maximum in the afternoon extends in winter only to a height of about 60 m. above the ground. Above that height the opposite type of variation is found, with a maximum in the night. The neutral zone between the two types is considerably higher in the summer, probably at about 300 m.

A most obtrusive object in any view of the city of Rio de Janeiro is the elevation known as Costello Hill. Notwithstanding the strikingly picturesque effect, the presence of the hill is highly objectionable, since it cuts off the cooling winds from the city. For a hundred years or more it has been proposed that this obstruction be removed, and now a syndicate has been formed which has applied to the Government for permission to level the hill, using the material removed to reclaim a large area of submerged land. The work will involve the removal of 47,000,000 cubic yards and it is estimated that the cost will be $10,000,000.

One of the greatest conservation factors in the dairy industry is found in the manufacture of powdered milk by processes which began to come into wide use about 15 years ago. The last available census figures for 1914 gives the total production of powdered milk as 20,000,000 pounds a year in the United States, of which New York State made almost half, with Wisconsin second and Michigan third. Nine pounds of milk powder represent 100 pounds of milk, and all forms of milk, such as whole milk, skim milk, buttermilk, and cream, are now dried successfully, as well as modified milk for infants' food. Dried milk products are in such demand that this country has never had a surplus for export.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 4

1,248,467. AUTOMATIC PUMPING SYSTEM. Earl E. Eby, Wilkinsburg, Pa.

1,248,481. FLUID-OPERATED DRILL. Louis W. Greve, Cleveland, Ohio.

1,248,487. APPARATUS FOR REDUCING RESPIRATION. William Harrison, Detroit, Mich.

1,248,507. POP-GUN. Charles F. LeFever, Plymouth, Mich.

1,248,631. AIR PURIFIER AND HUMIDIFIER. Malcolm Dickerson, Newark, N. J.

1,248,657. CARRIER - DESPATCH POWER-CONTROL SYSTEM. Charles P. Hidden, Brookline, Mass.

1,248,658. SINGLE-TUBE PNEUMATIC-DESPATCH SYSTEM. Charles P. Hidden, Brookline, Mass.

1,248,664. GLASS-BLOWING MACHINE. August Kadow, Toledo, Ohio.

1,248,689. METHOD OF SHOOTING OIL-WELLS. James E. McAvoy, Foxburg, Pa.

1. The herein described method of shooting oil wells which consists in closing the lower end of the well hole against pressure and supplying compressed gas to the well below the tube, and then exploding a charge in the body of compressed gas.

1,248,740. UNLOADING DEVICE FOR AIR-COMPRESSORS. Wade H. Wineman, Chicago, Ill.

1,248,767. PNEUMATIC - DESPATCH - TUBE APPARATUS. Frederick Gage Whittier, Ipswich, Mass.

1,248,851. DISTRIBUTING POWDERED MATERIAL. Charles L. Heisler, Schenectady, N. Y.

1,248,861. PNEUMATIC LIFTING-JACK. John H. Holloway, La Fayette, Ind.

1,248,950. VACUUM GASOLENE - RENOVATOR. John J. Tokheim, Cedar Rapids, Iowa.

1,248,966. VALVE FOR PERCUSSIVE TOOLS. Russell H. Wilhelm, Easton, Pa.

1,248,972. PULP-FEED REGULATOR. Isaac J. Witham and George E. Mayo, Cheboygan, Mich.

1. In a pulp feed receptacle, an air container within said receptacle connected with a source of supply, the pressure in said container being controlled by the density of the pulp in said receptacle, and a gage connected with said container for recording the density of the pulp through the instrumentality of the air pressure in said container.

1,248,990. SMOKE - PREVENTER. Ransom Bailey, Milwaukee, Wis.

1,249,042. PNEUMATIC SHEET - SEPARATING MACHINE. Talbot C. Dexter and Ross Meredith, Pearl River, N. Y.

1,249,565. LIQUID-DISPENSER. William F. Wagner, Ambridge, Pa.

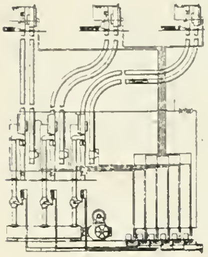
1,249,581. ENGINE-PRIMER. Raymond O. Wones, Maplewood, Ohio.

1,249,596. FLUID - PRESSURE REGULATOR. Arthur W. Cash, Decatur, Ill.

1,249,601. FLUID CONTROLLING AND METERING DEVICE. Sebastian Ziani de Ferranti, Grindleford Bridge, near Sheffield, England.

1,249,625. COMBINED BLOW-TORCH AND SOLDERING-IRON. Walter J. Herzog, Pekin, Ill.

1,249,692. EXHAUST-FAN FOR VACUUM-CLEANERS. William H. Upton and Oscar Stolp, New York, N. Y.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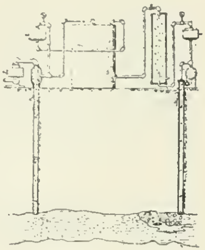
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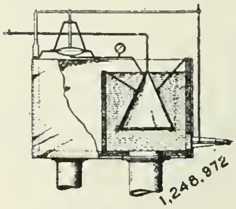
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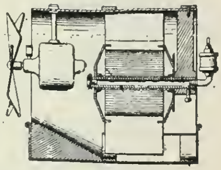
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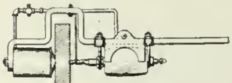
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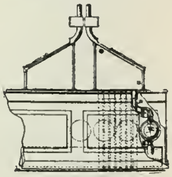
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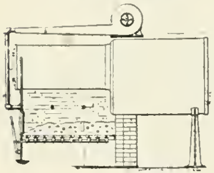
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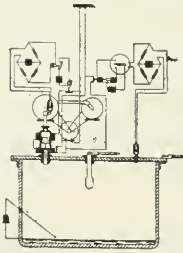
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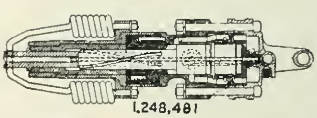
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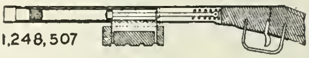
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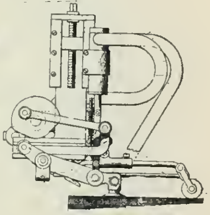
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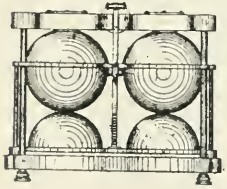
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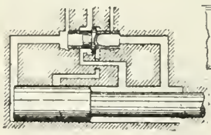
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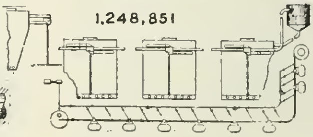

1,248,851

Pneumatic Patents December 4

1,249,045. PORTABLE DRILLING APPARATUS. Walter H. Diffendall, Hagerstown, Md.

1,249,232. APPARATUS FOR AND METHOD OF RECOVERING OIL AND GAS. Frederick Squires, Marietta, Ohio.

1. The method of recovering oil and gas which consists in introducing into the oil bearing stratum under pressure a heated, deoxidized gas to mix with the hydrocarbon vapor in the oil bearing stratum, and finally recovering the hydrocarbon from the mixture.

DECEMBER 11

1,249,382. DEVICE FOR AND METHOD OF MIXING GAS AND AIR FOR CONBUSTION. Stephen Hugh Hale, Kansas City, Mo.

1,249,392. PROCESS AND APPARATUS FOR OXIDIZING GASES. Ingenuin Hechenbleikner, Charlotte, N. C.

1,249,438. PNEUMATIC WHEEL. William Henry McCaffrey, Birmingham, Ala.

1,249,484. METER. George D. Pogue, St. Louis, Mo.

1,249,558. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

1,249,767. PRESSURE-GENERATOR. Guy F. Jontz, Moline, Ill.

1. In a pressure generator, a combustion chamber, means for compressing a gaseous mixture therein, comprising one piston reciprocating in said chamber, there being a valve controlled port between one side of said piston and said chamber, and a second piston reciprocating in the said first mentioned piston for compressing the charge into the said combustion chamber, means for igniting the compressed gaseous mixture, and a reservoir for receiving the ignited mixture, communicating with said combustion chamber.

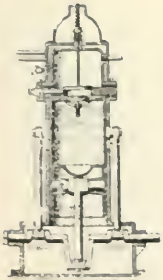
1,249,777. PNEUMATIC PIANO-ACTUATING VALVE. Walter A. Kruck, Camden, N. J.

1,249,822. ICE - MACHINE COMPRESSOR. Henry D. Pownall, Canton, Ohio.

1,249,887. LIFE-SAVING RAFT. John Benyak, Glassport, Pa.

1,249,921. HYDRAULIC AIR-COMPRESSER. Kennedy Dougan, Minneapolis, Minn.

1. A hydraulic air compressor comprising a cylinder in which the air is compressed by a moving column of water, means having intermittent communication with said cylinder for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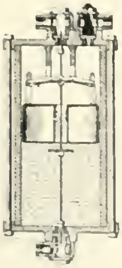
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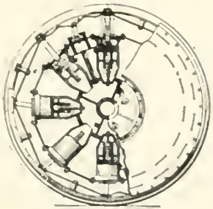
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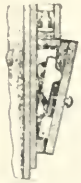
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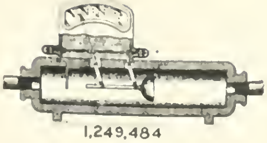
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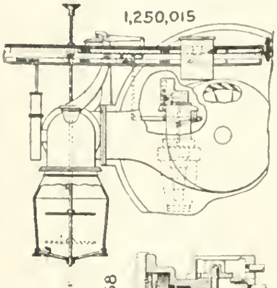
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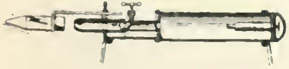
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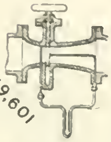
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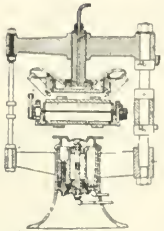
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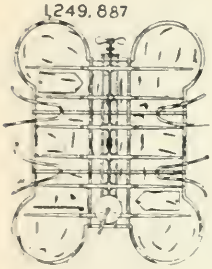
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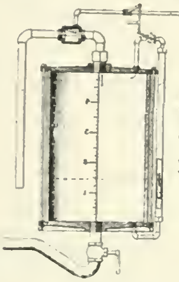
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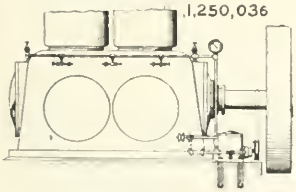
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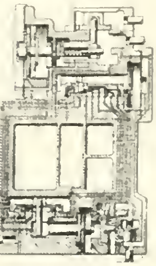
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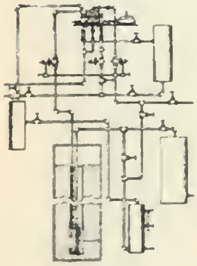
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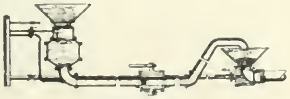
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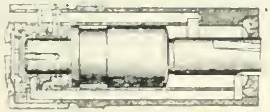
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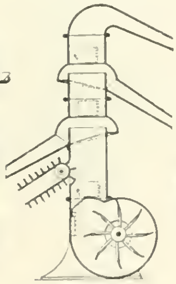
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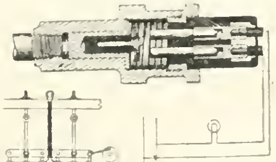
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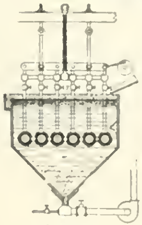
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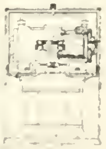
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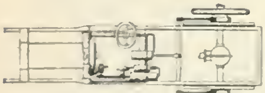
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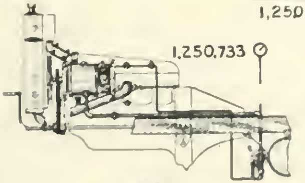
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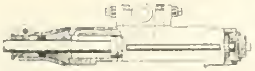
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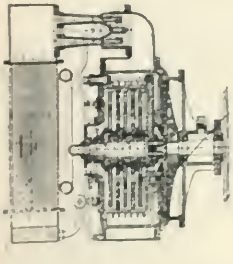
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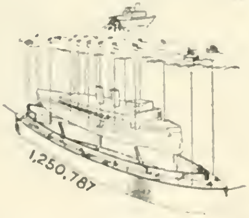
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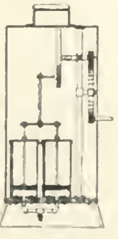
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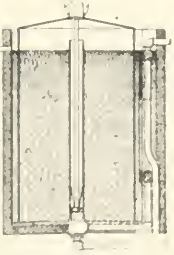
1,250,492

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admitting and directing the water suddenly into the same, said means operating thereafter to open the cylinder and permit the escape only of that part of the column of water which had entered the said cylinder.

1,249,939. VACUUM FUEL-FEED SYSTEM. Wray Falwell, Fitchburg, Mass.

1,249,994. MOLDING-MACHINE. William H. Nicholls, Brooklyn, N. Y.

1,250,005. CENTRIFUGAL COMPRESSOR. Edmund M. Phillips, Lynn, Mass.

1,250,015. CONSTANT-VOLUME GOVERNOR. Richard H. Rice, Lynn, Mass.

1,250,029. CENTRIFUGAL COMPRESSOR. Christopher A. Schellens, Marblehead, and George W. Pentheny, Lynn, Mass.

1,250,036. OILING APPARATUS. Thomas Shipley, York, Pa.

1,250,078. COMPRESSED-AIR TANK. Martin B. Barkman, Hillsboro, Kans.

1,250,104. PNEUMATIC REGULATOR. Adolph P. Gustafson, Chicago, Ill.

1,250,111. EXCESS - BRAKE - CYLINDER-PRESSURE-CONTROL MECHANISM. Willis C. Webster, Dubois, Pa.

1,250,553. APPARATUS FOR SORTING HETEROGENEOUS MATERIALS. Daniel R. Bryan, Chatham, N. J.

1,250,733. PNEUMATIC STARTING MECHANISM FOR AUTOMOBILES. Clinton L. Walker, Piedmont, Cal.

1,250,787. MEANS FOR RAISING SUNKEN VESSELS. Gedeon Breault, Pawtucket, R. I.

1,250,918. METHOD OF AND APPARATUS FOR MIXING AND DELIVERING CONCRETE. John H. MacMichael, Toledo, Ohio.

1,250,931. ROCK DRILL. George H. Gilman, Claremont, N. H.

1,250,932. PRESSURE-FLUID MOTOR. George H. Gilman, Claremont, N. H.

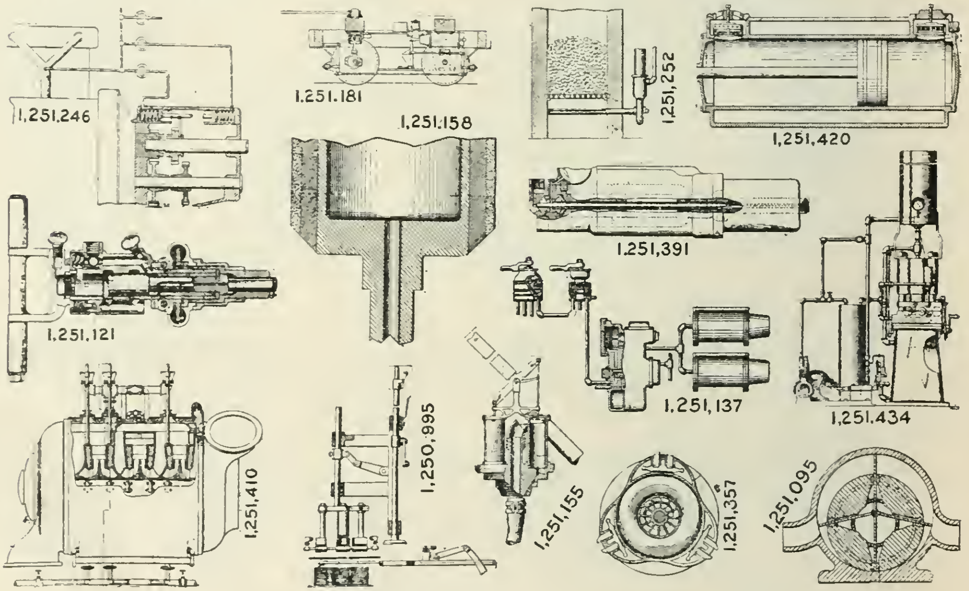
DECEMBER 25

1,250,995. PATCH - APPLYING MECHANISM FOR WINDOW-ENVELOPS. Carl O. Ekvall, Brooklyn, N. Y.

1,251,095. FLUID-MOTOR. Mathias A. Patton, Idaho Falls, Idaho.

1,251,121. PNEUMATIC TOOL. Mather W. Sherwood, Franklin, Pa.

1,251,137. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.



Pneumatic Patents December 25

DECEMBER 18

1,250,196. GAS-TURBINE. Emile Louche, Boulogne-Sur-Mer, France.

1,250,210. FLUID - PRESSURE - CONTROLLED SWITCH. Harry Y. Norwood and Fred. K. Taylor, Rochester, N. Y.

1,250,232. PUMP. Paul Schou, Copenhagen, Denmark.

1,250,303. FLOTATION APPARATUS. William E. Greenwalt, Denver, Colo.

1,250,304. AIR-GUN. William B. Greenleaf and Ernest S. Roe, Plymouth, Mich.

1,250,361. AIR-BRAKE SYSTEM. Frederick E. Shallock, San Francisco, Cal.

1,250,417. COMBINED WATER AND PNEUMATIC PUMP. Jesse B. Barrett, Jamestown, N. Y.

1,250,474. AUTOMOBILE PUMP. Atha W. Lee, Bingham Canyon, Utah.

1,250,475. AUTOMATIC AIR SPRING. Richard Liebau, New Haven, Conn.

1,250,492. SUCTION-PRODUCING MACHINE. Theodore W. Nygreen, Bellingham, Wash.

1,251,155. FLUID-PUMP. Albert Wiltz, Addy, Wash.

1,251,158. FORM-ROLLER. Henry A. Wise Wood, New York, N. Y.

1,251,175. METHOD OF AND APPARATUS FOR STRIPPING RUBBER JARS FROM CORES. Harry L. Boyer, Trenton, N. J.

1,251,181. AIR-BRAKE SYSTEM FOR TRUCKS. Elbert G. Chandler, Portland, Oreg.

1,251,246. VACUUM GEAR-SHIFTING DEVICE. Raymond F. Landis, Reading, Pa.

1,251,252. STEAM AND AIR MIXER FOR GAS-GENERATORS. Ferdinand Logan, Phoenixville, Pa.

1,251,357. PNEUMATIC VEHICLE - WHEEL. Adolph W. Eckhardt, New York, N. Y.

1,251,391. ROCK-DRILL. William H. Leonard, Denver, Colo.

1,251,410. COOLING CENTRIFUGAL COMPRESSORS. Fred Elmer Norton, Worcester, Mass.

1,251,420. VALVE FOR AIR-COMPRESSORS. George M. Richards, Philadelphia, Pa.

1,251,434. DRILL-SHARPENER. William A. Smith, Denver, Colo.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

Vol. xxiii MARCH, 1918 No. 3

TAMPING A SET OF CROSSINGS

SCARCITY OF MEN AND GROWING USE OF AIR IN RAILROAD MAINTENANCE*

In the present acute labor shortage with men practically unobtainable at reasonable rates in sufficient numbers to carry on even the most urgent work, compressed air is of particular advantage to the maintenance of way department because of its adaptability to various kinds of maintenance work.

PNEUMATIC TIE TAMPERS

What has now come to be the most common use of compressed air in railroad maintenance is in the work of tie tamping. The tamping tools may be operated either by utilizing existing air lines, as in the case of the Pennsylvania, where a permanent installation of air for use in connection with pneumatic switch and signal systems and other purposes is available in the mainline territory between New York and Pittsburgh, or in connection with portable gasolene-driven air compressors provided for the purpose.

PORTABLE COMPRESSORS

Many of the large eastern roads, including the Lackawanna and the Lehigh Valley, are using tamping outfits operated in connection with portable compressors. The first outfits were installed on the Lackawanna in the summer of 1916, when five outfits of the four-tool type were placed in service on the west end of the Buffalo division as a test installation. These outfits were placed on alternating sections to test out their efficiency as compared with hand tamping on the adjoining sections, and as the result of this test 25 additional outfits were purchased and placed in service in June, 1917. With these outfits, in addition to the first five, the 217 miles of main line between Halsted, Pa., and Buffalo, N. Y., was completely equipped, leaving the 179 miles of main line between Hoboken, N. J., and Halsted unequipped.

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*Condensed from Railway Maintenance Engineer.

DIFFERENT CONDITIONS OF HAND AND MACHINE WORK

In 1917 the gangs were short-handed and the labor employed was below the usual standards, causing a decline in gang efficiency. Working under these conditions, it was found that machine work was done at a less cost and was better done than the hand tamping. This was due to the fact that an efficient foreman was able to control the machine work to a greater extent than the hand work. With the machine a good job is a matter of position and time of tamping, which the foreman could control, thus in a measure overcoming the inefficiency of the labor, while with hand tamping it is a matter of strength and willingness as well, both of which are beyond the control of the foreman. The outfits were found to be especially valuable for gangs which were short handed because of the greater output of work units per man. With six men to the section as a minimum a foreman was able to keep his track in good line and surface and, because of the superior work of the tamper, once the track was in shape it held better.

MOST EFFICIENT ON THE MOST DIFFICULT WORK

The tampers were found particularly efficient in complicated track work as in yards and at interlocking plants where hand tamping is practically impossible. They were also found to be economical in resurfacing as loose ties may be tamped without digging out the ballast when the work is done with the machines. With hand tamping this digging out is necessary to tamp the ties properly.

SELF ADVERTISING TOOLS

On the strength of the results obtained early in 1917, the Lackawanna purchased 25 additional outfits. These have been delivered and 7 more are now under construction, making a total of 62 outfits in all. With these placed in service the entire main line between Hoboken and Buffalo will be equipped.

OTHER COMPRESSED AIR USES

The Lehigh Valley utilizes the compressors the year around. In winter they are employed on the line to supply air to boilermakers' tools, thus releasing locomotives generally used for this purpose. They are also used by the bridge and building department in sawing and boring bridge and other timbers and it is proposed to utilize them for operating saws for cutting timbers. Compressors have also been utilized by the Lehigh Valley to supply air to train lines in yards where the regular equipment was one of order or the supply was insufficient. Here again they replaced locomotives.

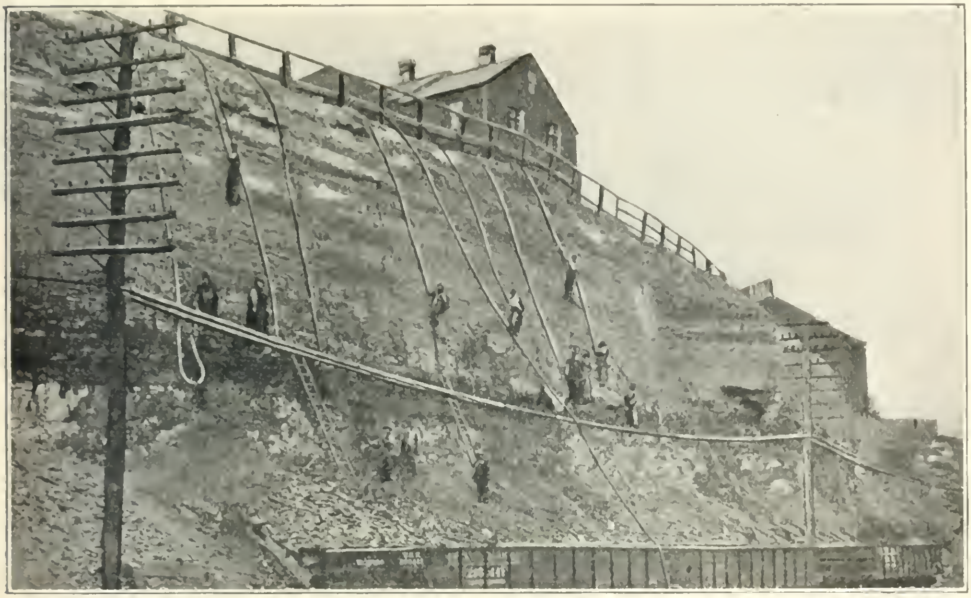
By the substitution of a suitable bit or chisel for the tamping bar the outfit may be used for cutting pavements and concrete foundations away from the rails in city streets as has been previously described. On railways with track pans on the line the cutting tools may be used in combating ice conditions. By the substitution of other tools for the tamping tools, the compressor may be utilized in cleaning rust from steel, as a sand blast, for painting steel or other structures.

In placing the rail on the 26 miles of line of the New York Connecting Railway, the compressors were used in connection with Ingersoll-Rand Little David No. 11 S. E. reversible drills in placing screw spikes. Exclusive of the overhead expense and the depreciation the cost per spike placed by this method averaged $0.008.

NOVEL ROCK CUTTING JOB

The Pennsylvania Railroad recently employed air in a novel way for widening a rock cut on its line between East Liberty, Pa., and Pittsburgh. The rock removed is known as Pittsburgh shale and, while soft and having decided cleavages, is hard enough to make its removal by hand picks difficult. The local restrictions prevented the use of explosives and as the work was of considerable magnitude, being 400 ft. long with a thickness ranging from 10 to 25 ft., it was decided to utilize tamping tools fitted with bars with pick points in place of the tamping bars to remove the rock.

Rope slings to support the men and tools were attached to the fence at the top of the cut and, together with an air hose, were strung along the face of the cut. The work commenced at the top of the wall and progressed downward in shelves, each cut being made to the full depth back to the permanent face. The operator picked downward through the rock for a distance of about 8 in. and then drove



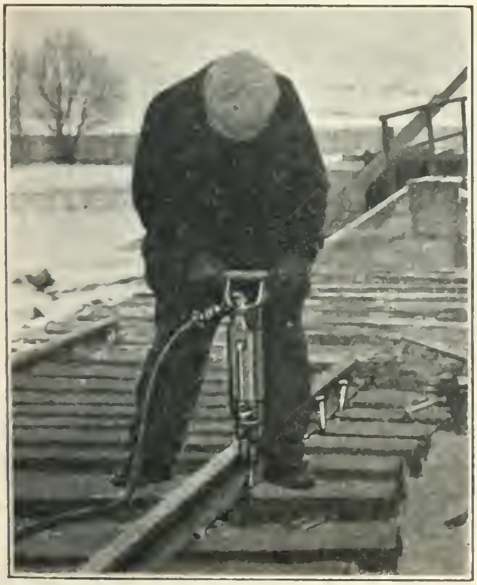
NOVEL ROCK CUTTING JOB

the pick into the horizontal seam, breaking the rock off in layers about 6 in. thick.

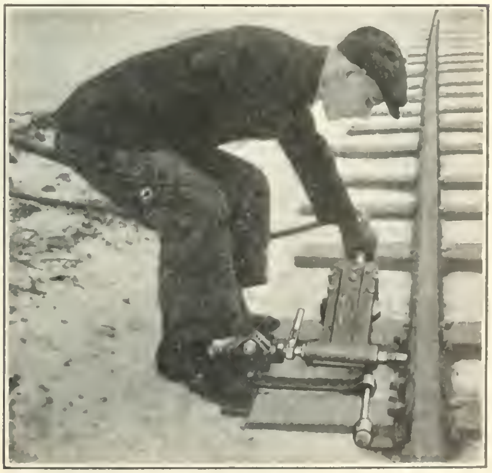
Owing to its brittle nature the rock broke off in comparatively small pieces, which became further broken up in the downward course into gondola cars which were placed alongside the work. Inclined plank aprons were provided to enable the spoil to be loaded into the cars with the least effort. The method of placing the slings and the loading of the material are shown in the photograph. The air supply for the tools was obtained from the supply line which is used in connection with the signal system.

RECENT DEVELOPMENTS IN AIR TOOLS

Two air-operated tools which are applicable to maintenance work have recently been perfected by the Ingersoll-Rand Company, and are



PNEUMATIC SPIKE DRIVER



PNEUMATIC RAIL DRILL

now in use on several of the eastern roads. The tools are a spike-driving hammer for seating cut spikes and a pneumatic rail drill, which is used for drilling rails for joints and for bonding.

SPIKE DRIVER

The pneumatic spike driver is larger than the riveting hammers familiar to railway men. The complete machine is 25 in. long and weighs slightly more than 60 lb. It strikes a slow, hard blow under the positive control of a trigger located on the inside of the T handle and when starting the spikes it is possible to throttle the hammer blow to a light tap. The piston of the tool transmits the driving force through an interposed hammer block, which is cupped out to accommodate the head of the spike. From a time-saving point of view it has been found most efficient to start the spikes by hand and finish the driving by the machine. It takes approximately five seconds to drive home a spike. One man with a spike driver can follow three men starting spikes and drive home all they can set up.

PNEUMATIC DRILL AND "OLD MAN"

The pneumatic drill, which is known as the No. 9 "Little David," is equipped with a three-cylinder motor, giving it a constant power impulse. It weighs 37 lb. and operates at a speed of 140 r.p.m. The spindle socket accommodates No. 4 Morse taper shanks. As shown in the photograph, a lever type "Old Man" has been developed for use in attaching the drilling machine to the rail. Its quick clamping action minimizes the time required for a set up and the constant pressure drill feed is a further advantage. Observations for actual drilling speed show an average of 45 sec. required for an 80-lb. rail and 1 min. 20 sec. for a 120-lb. rail.

INGENIOUS SOLUTION OF DIFFICULT SALVAGE PROBLEM

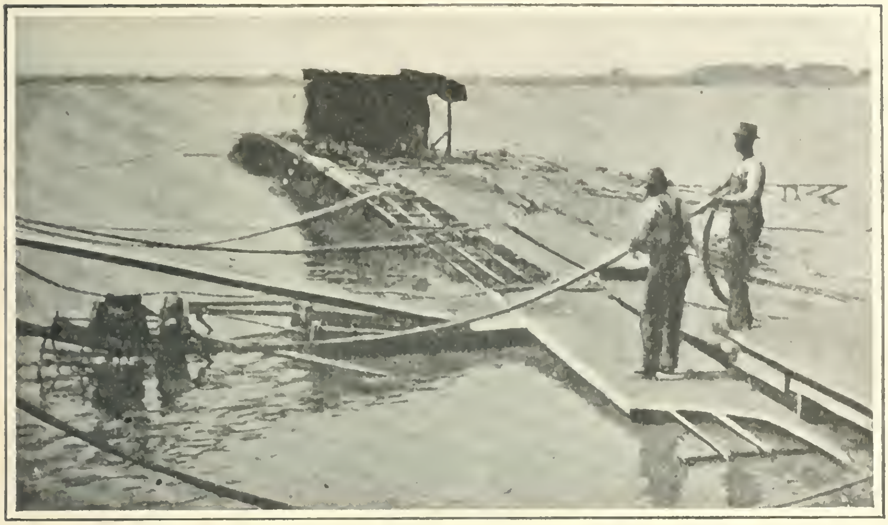
Marine records contain very few instances in which overturned and sunken ships have been refloated. A vessel in that position presents a very awkward mass to handle. One of the foremost difficulties is that of controlling the water inside of the craft when the ship is righting herself and rising to the surface. The surging water may all too easily upset the boat's stability at a critical moment in the operations and heel her over so far that she will refill and sink again, possibly bottomside up.

THE GUT HEIL AFLOAT

The recent salvage of the German tanker "Gut Heil" is of especial interest because the ship was commonly considered a total loss and a hopeless task for wreckers. The vessel foundered in the latter part of 1912 just after leaving the dock at Baton Rouge with a full load of $3,800 tons of oil. A chain cable fouled her propeller, and while unmanageable, the steamer was carried by the current down upon two other vessels. Each tore a hole in the "Gut Heil's" port side, and through these wounds the waters of the Mississippi flooded into her. Sometime afterwards, her underwriters, the Standard Oil Company, tried to raise her. They succeeded up to a point, but the free surface of the water inside of her invited disaster—the fluid ballast started the craft heeling, and before her angular movement could be arrested, she rolled over, refilled, and sank to the riverbed on her injured side. The efforts to refloat her entailed an outlay of more than $100.000.

Nothing further was done by her underwriters save to recover some of the bulk oil she carried. After that, the tanker was abandoned, and just because she did not seriously interfere with navigation the United States authorities failed to dispose of her by blowing her up, as is generally done with derelicts. In the course of four years and more, the mud of the Mississippi worked into the sunken vessel and loaded her with substantially 4,000 tons of silt, adding just that much more to the improbability of ever raising the steamer. Such were the general conditions when a New York salvage concern was asked a few months ago to try to refloat the ship. The problem presented a number of angles which had to be dealt with successively in order to bring about a state of affairs that would favor her ultimate recovery.

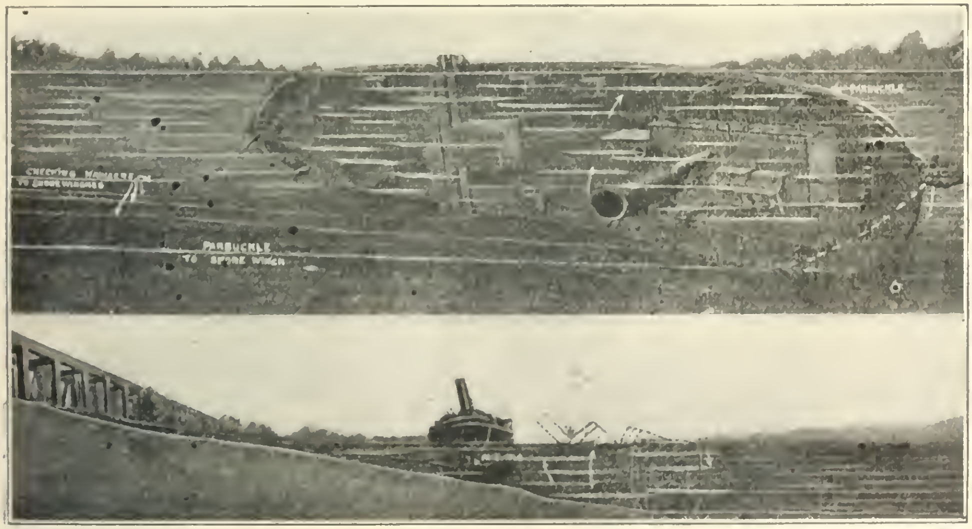
First, the mud inside of her had to be removed; second, the two injuries had to be closed and the tanker otherwise made structurally tight so that compressed air could be used for the final expulsion of the water inside of her; third, it was needful that the distribution



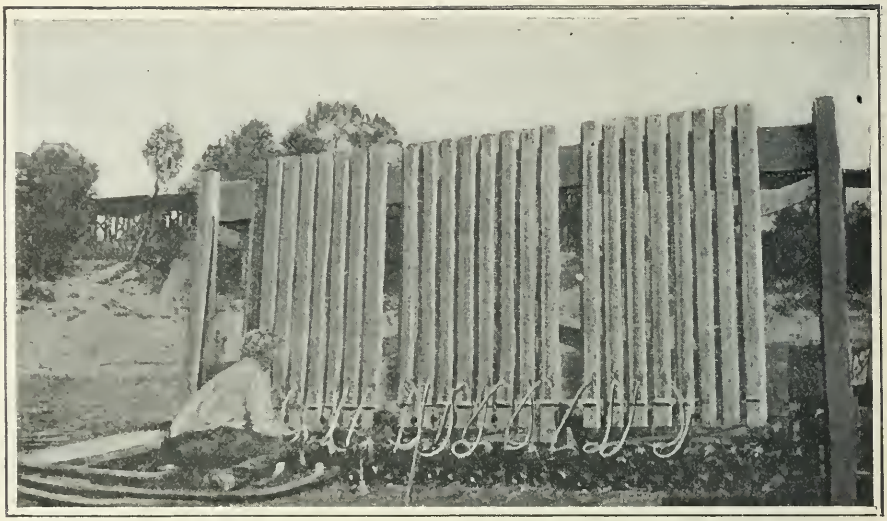
SIDE OF GUT HEIL JUST OUT OF WATER

of water ballast and buoyancy should be susceptible of extremely nice control throughout all of the steamer's compartments; and, finally very positive checks had to be provided to hold the boat from acquiring a sudden excess heel through the momentum induced when swinging into a vertical position.

To free the "Gut Heil" of mud, the wreckers devised an ingenious and very effective compressed air siphon. This apparatus served the double purpose of loosening the mud and then raising it to the surface. The siphon handled the problem a good deal better than the available types of salvage pumps. With 3,000 tons of the silt thus removed it was possible for divers to enter the vessel and examine her structural condition. They found that her main longitudinal bulkhead was only loosely connected with the two decks above and, therefore unsuited in that state to isolate the neigh-



SKETCH OF THE GUT HEIL AS SHE LAY AND OF THE MANNER OF RIGHTING



MERCURY TUBES FOR WATCHING THE PRESSURE IN THE COMPARTMENTS

boring compartments so that they might be dealt with separately in applying compressed air for the final expulsion of their contained water. Binders of reinforced concrete, fixed in position while the tanker lay submerged, tied the decks and the bulkhead together and effectually sealed the joints. Reinforced concrete patches, put in position under water, also closed the two wounds in the hull plating caused by the collisions.

To each compartment—in most instances through the hatch covers—air supply and water exhaust connections were installed. The admission of compressed air forced the contained water outboard, and the release of the air pressure permitted the re-entry of the water. The air was supplied by hose, and all of these conduits were centered at a swinging platform erected upon the rail of the upturned side of the ship. Each lead of hose was there operated by its own valve, tapping flasks duly charged for the service. Upon this same operating stage were installed two groups of gages: one group, of the usual dial type, showing the volume of stored air available for the expulsion of water, and the other group, composed of 40-inch mercury columns, indicating the measure of air in each submerged subdivision of the vessel. This arrangement provided the wrecking master with a visible record of the internal distribution of buoyancy and water ballast; and by means of the bank of valves immediately at hand it was possible for him to make instant and very nice adjustments of these opposing forces as the movement of the craft necessitated.

But notwithstanding this seemingly complete equipment, the wreckers determined to take no chances. Therefore they secured to her at several points wire rope purchases which were led ashore to tackles attached to 40-ton blocks of cement buried in the ground. The tackles were operated by power-driven winches. Five of these purchases were made fast to mooring bits on the deck of the tanker on her lower side; and great credit is due the divers for the skillful and thorough way in which they did this difficult work. The sixth purchase in the form of a salvor's parbuckle, was secured to a deck bit on the upper side of the deck, then led over the upturned side, down through the propeller well, thence under the ship, and from there to the shore. The latter purchase made it possible to exert a righting force, while the five other purchases enabled the wreckers, at one stage of the work, to draw the ship shoreward into shallower water and, later, served to check the angular movement of the tanker when she was coming up to a vertical posture.

The salvors took no chances, as the foregoing preparations make plain, and it was wise, because they were thus able to deal with a number of unexpected contingencies. For instance, while the compressed air siphons functioned very well, indeed, still about a thousand tons of mud remained in the craft clinging to the upper surfaces of compartments at the time righting operations were started. When the steamer was beginning to free herself from the bottom and to turn on her longitudinal axis, this mud dropped away from its resting places and fell to the lower sides of the several subdivisions. This radically altered the "Gut Heil's" center of gravity, and for a while effectually arrested her angular motion. However, her changed position vertically gave the wreckers a chance to pull her farther inshore where she grounded and took a still better posture for subsequent work upon her.

When the ship was finally restored to an even keel, but while still resting upon the riverbed, it was discovered that the hole through the hull into the engine room had not been perfectly sealed by the reinforced concrete patch placed over it by the divers. That is to say, there was a leak which made it impossible to fill the space with compressed air in order to drive out the contained water. Therefore, it was decided to drain the engine room by suction pumps, and the leak was successfully stopped by means of a canvas patch applied externally. This patch was reinforced by strips of wood placed horizontally which, while stiffening the fabric and holding it stretched, left it flexible enough to adjust itself to inequalities of surface where the steel plating had been torn at the time of collision. This may seem an unimportant detail, but that expedient shows how it may be possible to deal quickly with a wound in any of our fighting ships or damaged war freighters. The usual woven mattress of hempen cable, such as is generally advocated in the naval service, is a clumsy thing to handle and not susceptible of rapid fabrication.

The "Gut Heil" is a vessel 321 feet long; and on a 21-foot draft carries 3,800 tons of oil. As she lay submerged she represented a dead weight of substantially 6,000 tons. The wreckers were engaged about two months in their preparations and the ultimate refloating of the craft. The latter operation was carried through in the course of a single day. When sunk, in 1912, the ship was valued at approximately $300,000. Today, she would bring a round million of dollars. Notwithstanding her five years' submergence, she is structurally sound, and her machinery, though very dirty, is in excellent condition. The turning over and refloating of the tanker, although commonly considered an impossible wrecking feat, illustrates what the resourceful scientific salvor can achieve now in the face of many physical difficulties; and it emphasizes the part certainly to be played by the wrecker in restoring to service ships that are sunk by routine mishaps or sent to the bottom by the ravaging submarine. —*Scientific American.*

MILLIONS OF TONS OF COAL SAVED BY SOOT BLOWERS

A recent statement by the Diamond Power Specialty Company, Detroit, points out that its mechanical soot blowers saved the nation 2,200,000 tons of coal during 1917 by keeping heating surfaces clean, and in this way enabling more efficient heat transfer from furnace gases to boiler heating surfaces. This company reports at a conservative estimate about 11,000,000 boiler horsepower in the United States are being maintained efficient by Diamond soot blowers. If these boilers average 2500 hours operation yearly, and allowing 4 pounds of coal per boiler horsepower per hour, the coal consumption will be in the neighborhood of 55,000,000 tons. Both the above estimates tend to belittle the coal consumption.

The Diamond soot blower will save 4 per cent, and often 8 per cent, of the fuel burnt by preventing the adherence of soot upon the heating surfaces, which for the above coal consumption represents a saving of 2,200,000 tons of coal annually when figured on 4 per cent basis. Expressed in dollars this represents a financial saving in the fuel bill of between $8,000,000 to $9,000,000. With normal loading railroad congestion and car shortage have been reduced to the extent of 44,000 carloads of coal.

A PORTABLE LIGHT RECORD

What is undoubtedly the largest contract for lights ever made in this country—and probably in the world—was closed lately when the Alexander Milburn Company of Baltimore received an order from the United States Government for portable lights representing the almost staggering total of more than 50,000,000 candlepower. They are intended for use in France, where they will play an important part in the feats of engineering behind the lines. Free communication between the front line and the bases—facile transportation, by rail, motor and wheel—is absolutely vital. The work of keeping these lines open is carried on day and night by means of these lights. These lights are of the portable carbide kind, such as the company has specialized for many years, and which the Government has standardized for army and navy uses. They use ordinary commercial carbide, a fuel sold throughout the world and obtainable in any quantity. It is safer than oil or gasoline and is readily handled.

RECENT DEVELOPMENTS IN AIR-PUMP DESIGN

BY E. P. JONES*

With the earliest types of surface-condensing equipment it was usual to employ one pump for removing both the condensate and air from the condenser. This pump was known as a "wet" air pump, and a good example of this type is the Edwards air pump, one of the most efficient of its class. The chief advantages of this type of pump are: (1) Low power required for driving; (2) positive action and consequent stability; (3) ability to cope with excessive air leakages. While the Edwards pump is still an excellent pump for units up to, say, from 3000 to 4000 kw., it must be remembered that, with the ever-growing size of power units, its disadvantages should be kept in view. For large units with Edwards pumps it is necessary that they should run at a very low speed, and consequently they are very cumbersome and take up a large amount of floor space.

With jet plants the Edwards pump is sometimes used as a dry air pump. It is necessary, of course, to provide a small quantity of water for sealing purposes. Volumetric efficiency in this pump varies considerably with the degree of vacuum required and decreases as the vacuum increases from about 50 per cent. at 3½ in. absolute pressure to 18 per cent. at 1 in. absolute pressure. Another system is that in which a dry air pump of the reciprocating type is used to remove the air and uncondensed gases and a separate pump to remove the condensate. The advantages and disadvantages of this system are the same as for the Edwards air pump, but the efficiency is rather better.

Previous to the introduction of the steam turbine condensing-plant equipments were furnished with air pumps of one or other of the types mentioned, but as soon as the turbine became a commercial proposition it was necessary to look for a type of pump having features specially adapted to its requirements. With turbine installations it is essential to use a high vacuum in the condenser, whereas with steam engines of the reciprocating type a vacuum of more than 26½ in. was seldom required. In fact, it is questionable whether using a vacuum higher than 26½ in. would not be considered a disadvantage. With the turbine, however, a vacuum less than 27 in. is rarely asked for, and sometimes the specified figure is as high as 29.25 in. with the standard barometer reading of 30 in. In considering these figures, due allowance must be made for the altitude of the place. The most economical vacuum for a turbine installation depends on a variety of things, and each case has to be considered on its merits.

On reference to steam tables it will be seen that an increase in vacuum from 27 in. to, say, 29 in., other conditions, as air leakage, remaining the same, necessitates an increase in the capacity of the air pumps from 1.00 to 3.25, which for a large installation with Edwards or reciprocating dry air pumps is a very serious matter. Therefore various types of rotary pumps, which are specially suitable for dealing with large volumes of air at low tension, have been designed since the adoption of the steam turbine, several of which have proved very successful. The general design of these pumps is much the same, in so far as they use a certain quantity of what is termed "operating water," for which various devices have been invented to cause this water to move in such a manner as to entrain the air from the condenser and discharge it to the atmosphere. Perhaps one of the best-known rotary dry air pumps is the one invented by Prof. Maurice Leblanc. It has been used to a large extent all over the world, and its action is shown by Fig. 1. This pump is capable of maintaining a very high vacuum, and for this reason, coupled with the fact that it is very simple in construction and not likely to get out of order, it has been largely used for turbine installations. It cannot be claimed for this pump—or, indeed, for any type of rotary air pump—that it can successfully deal with an excessive air leakage, but consideration will show that this quality is not essential in the case of turbine installations where air leakage is reduced to a minimum by the adoption of steam- or water-sealed glands where the shaft passes out of the turbine casing. With a sur-

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*Institution of Engineers and Shipbuilders, Scotland.

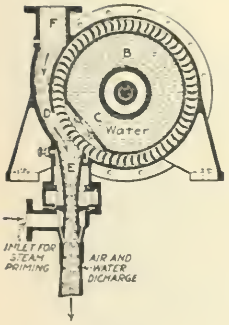

FIG 1

LEBLANC AIR PUMP

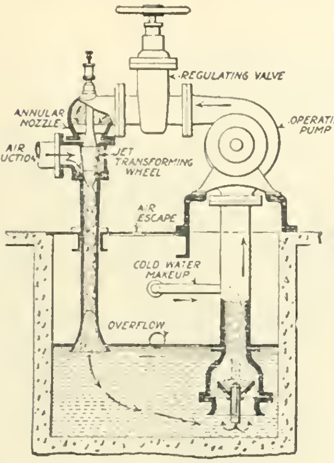

FIG 2

WORTHINGTON AIR PUMP

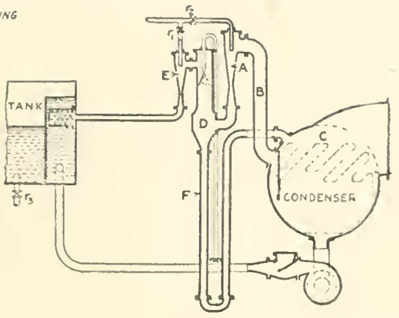

FIG 3

EJECTAIR AIR PUMP

face-condensing plant it is only possible for air to be brought into the system by the feed water and carried over with the steam, or by leaking in at the joints. With jet plants, the air brought in with the injection water has to be allowed for in addition to the above, and it is for this reason that the air pump on a jet-plant requires to be larger than that for a surface-condensing plant doing the same steam duty.

The power required to drive these pumps is rather higher than that required for an Edwards or other good type of reciprocating air pump, and consequently a good deal of attention has been paid recently to another type of pump which would incorporate the simplicity of compactness of the rotary pump and the low-power consumption of the Edwards and other reciprocating pumps. The general trend of thought seems to have been in one direction, and there are now on the market and in commercial use air pumps operating on the ejector principle. Nearly all the leading condenser manufacturers now construct air pumps of this description.

THE NEW EJECTOR AIR PUMP

The Worthington Pump Co., Ltd., London and Newark, manufacture a patent hydraulic vacuum pump on the ejector principle, as illustrated by Fig. 2, which consists of: (1) The injection head, (2) the air-suction chamber, (3) the rotary wheel, (4) the throat and tail pipes. The operating water passes between two nozzle rings, and the cone of water passes between the body of the wheel and the outer sleeve, impinging on the inclined surfaces of the vanes, thus imparting a rotary motion to the wheel. To operate the pump it is necessary to provide a certain amount of sealing water, which is supplied from a tank situated as conveniently as possible to the pump. The sealing water takes up a certain amount of heat from the air and water vapors withdrawn by the air pump, and a piping arrangement is provided for withdrawing a certain amount of this water by means of a bypass connection on the operating pump discharge, this bypass being fitted with a controlling reflux valve. The quantity of water withdrawn in this manner is replaced by make-up water drawn from the circulating inlet-piping or an independent supply, thus cooling the water used in the cycle of operation. This apparatus is doing regular service on one of the turbo-alternator groups at the Glasgow Corporation Power Station at St. Andrew's Cross. A number of installations have also been supplied to other concerns.

Willans & Robinson, of Rugby, manufacture the Willans-Muller ejector air pump, which is operated by the circulating water, either on the series or shunt system. With the series system the whole of the circulating water passes through the ejector before entering the condenser. With the shunt system only a portion of the cooling water passes through the ejector, and, after use, is returned to the pump suction or the source of supply. A third method of operating this ejector is by the separate-pump system, in exactly the same manner as described in referring to the Worthington pump. The whole plant is very similar to that made by the Worthington Pump Co. The Glasgow Corporation has a set of this apparatus at work at Pinkston Power Station, and good results have been obtained, and a second set is just being installed at St. Andrew's Cross.

Another type of ejector air pump is that manufactured by Hick, Hargreaves & Co., Ltd., Bolton, under license from the Mason Breguet, Paris. This is really two ejectors working in series, with an auxiliary condenser placed between the first and second stage of the ejectors. A number of these air pumps, termed "ejectairs," have been supplied to, or are under construction for, the French Navy. Referring to Fig. 3, it will be observed that the primary ejector *A* is placed in direct communication with the main condenser *C*, and extracts the aërated vapor, being operated by a single steam jet or nozzle r_2. The mixture of steam and partly compressed vapor is then discharged to the auxiliary condenser *D*, and the water returned to the main condenser to be dealt with by the extraction pump. The second-stage ejector *E* is coupled up to the auxiliary condenser, and draws the air away, discharging it to the feed tank. An automatic air-inlet valve is fitted to the auxiliary condenser, to regulate the absolute pressure therein. It is claimed that taking air from the atmosphere in this manner materially assists the stability of the plant, and also renders it more flexible. These *ejectairs* are designed for working with steam pressures at 55 lb. per sq. in. or above, and with a special arrangement of nozzles lower pressures can be used in the primary ejector, although the advantage of this is not apparent if it is impossible to work the other ejector under the same conditions, neither is it clear whether this can be accomplished or not.

The curves, Fig. 4, show the performance of an *ejectair*. Steam to the ejectors had an absolute pressure of 125 lb. per sq. in., and the steam consumption is given as 194 lb. per hour, of which 129 lb. is recoverable. The apparatus worked in conjunction with a small jet condenser, dealing with 94 gal. of injection water per minute. Curve 1 gives the vacuums obtained with water leaving the condenser at a temperature of 91.4 deg. F. (33 deg. C.), and the auxiliary condenser out of action; curve 2 the volume of air dealt with in cubic feet per hour; curve 3 the vacuums obtained with given air leaks, and the water leaving the main condenser as for curve 1, but with the auxiliary condenser supplied with cooling water at 66.2 deg. F. (18 deg. C.); and curve 4 the volumes of air dealt with under the same conditions. It was calculated that the air coming in with the injection water and at leaky joints amounted to 1.102 lb. per hour (0.5 kg.).

The British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, and the Mirrlees Watson Co., Ltd., Glasgow, manufacture an ejector air pump under license from the Société Anonyme Westinghouse, Paris and Le Havre, which is another invention of Maurcie Leblanc. It is the outcome of many months of arduous research work, during which time innumerable difficulties were surmounted by the inventor, with the result that a really first-class ejector air pump has been evolved. Figs. 5 and 6 show the general arrangement of this apparatus. It will be noticed that the pump is arranged to work in two stages, and the steam is admitted to the second stage of the ejector by opening the stop valve *C*. Immediately *C* is opened, steam fills the annular space behind the nozzle plate, and finds its way into the throats of the group of nozzles *Y* attached to this plate; it then passes along the steam pipe which supplies the first-stage nozzles *X*, which are also attached to a nozzle plate. The supply of steam in this set of nozzles is controlled by the stop valve on the steam-supply pipe. The pump is connected to the condenser at the branch *D*, which is the air-inlet branch. At the entrance to each of the steam spaces fine wire-gauze strainers are

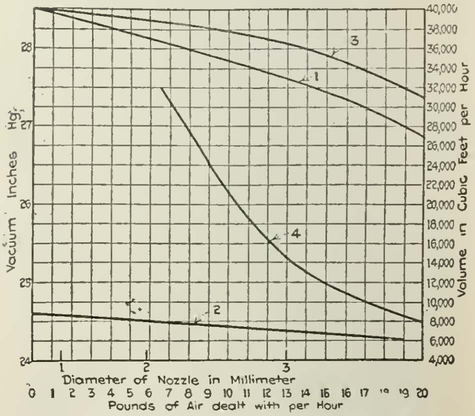

FIG. 4. PERFORMANCE OF AN EJECTAIR

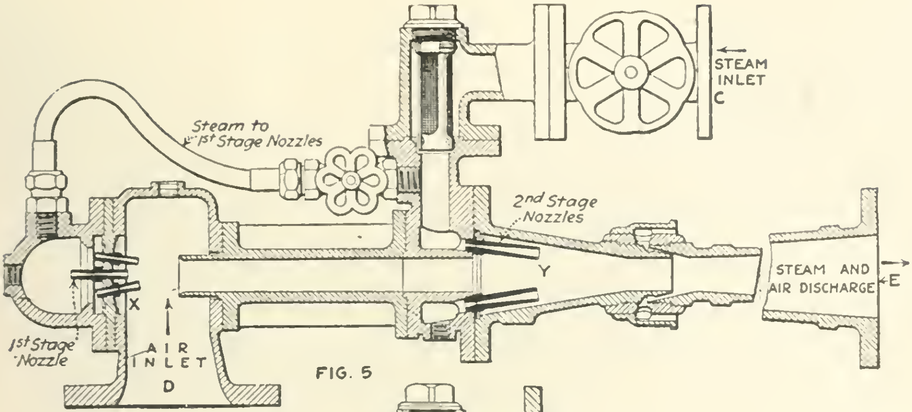

FIG. 5

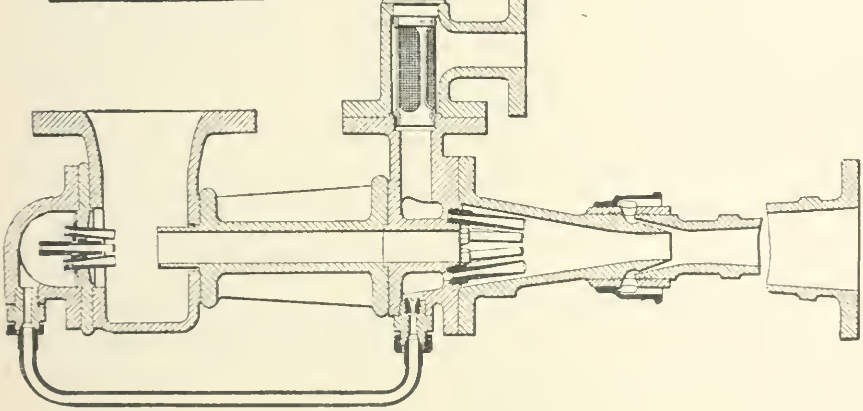

FIG. 6

TWO FORMS OF LEBLANC EJECTOR

fitted to prevent any foreign matter, which may have primed over with the steam from the boilers, from entering the nozzles, thereby intercepting any stoppage in the nozzle throats, and consequently a loss of vacuum. These nozzles are securely locked to the nozzle plates. The mixture of air and steam is discharged at the mouth of the cone *Y* and led away to the boiler-feed tank, so that the heat units contained in the operating steam can be reclaimed by heating the feed water. To start the pump to work, it is only necessary to open up the steam valve *C*, and the vacuum will at once begin to increase in the condenser or other vessel to be evacuated. When the vacuum gage becomes stationary, the first-stage steam-inlet valve is opened up to bring the vacuum to a maximum. A very important feature in this pump is the absence of moving parts. The simplicity of the apparatus is even more remarkable than that of the Leblanc rotary pump.

The advantages claimed are as follows: (1) Extreme simplicity; (2) the small amount of energy required for operating purposes; (3) the high efficiency obtained; (4) ease with which starting can be effected, and the small amount of attention required while at work; (5) ability to produce the highest possible vacuums; (6) stability. In scanning these claims we can pass over the first, which as already mentioned, is obvious; there are simply two steam valves to open. The second deserves some consideration. The operating steam in passing through the nozzles decreases in pressure, and consequently in temperature, and also, after passing through the nozzles, does work in accelerating the velocity of the air, increasing its temperature and compressing it. There is also a small amount of heat lost due to friction in passing through the diffuser portion of the ejector, which might be considered negligible. Beyond this, the whole of the heat in the steam can be utilized to heat up the boiler-feed water, and in order to obtain full benefit from the apparatus it is highly desirable to use the discharge from the ejector for heating purposes of some description. Thus both the steam and air can be made to do useful work. In view of this it must not be forgotten that when an ejector of this type is specified as requiring so many pounds of operating steam per hour, this is only the apparent quantity; the actual quantity is really far less, since the great majority of heat units in the steam are still available for further work. The actual heat units recovered can easily be calculated from steam tables, since it is known that the steam and air leave the ejector at a pressure of from 10 lb. to 12 lb. per sq. in. by gage. It will be observed that with a Leblanc multijector an auxiliary condenser is not required, and in this respect it differs materially from the "Berguet" *ejectair*. The employment of an auxiliary condenser has the disadvantage that the total heat units of the steam used in the first-stage ejector, which amount to an appreciable percentage of the total heat units used on the whole apparatus, are dissipated and lost. The makers give this percentage as about 33. Another reason for dispensing with the auxiliary condenser will be apparent from the following. In all steam-operated ejectors one of the difficulties that have to be contended with is the fact that the steam leaves the nozzles at a velocity varying from about 3,000 to 3,600 ft. per sec., while the velocity of the fluid to be entrained is practically nil. This is the cause of considerable loss of efficiency in any ejector, but if an auxiliary condenser be used the defect is doubled, because the velocity of the fluid to be entrained, which has been imparted to it by the operating steam during its passage through the first-stage ejector, is dissipated and lost as soon as it enters the condenser. The cooling water used on the auxiliary condenser has to be dealt with by the condensate pump, thus increasing the power absorbed by the plant. When working with surface condensers, this water must be of good quality, as it has to be returned to the boilers.

The third claim relates to efficiency. It is well known that ordinary single-stage ejectors only work well when the compression ratio is as 1:7, and it is partly for this reason that the Breguet Co. has introduced the auxiliary condenser, so that the vacuum obtaining in this condenser is about 25.6 in. with the barometer at 30 in., the compression being approximately as 11:76, or, roughly, 1:7. The over-all efficiency of this plant is, therefore, apparently still further reduced, because air is admitted from the atmosphere into the auxiliary condenser, which is under a vacuum of 25.6 in., and this, together with the air from the condenser, has also to be ejected by the secondary ejector to the atmosphere.

When Professor Leblanc set out to design his ejector he foresaw the possibility of using an intermediate condenser, but he also appreciated its disadvantages and decided to do without it if at all possible. At the same time he knew that it was essential to use two stages in order to get a stable and efficient ejector. With this end in view, certain steam nozzles were designed on the lines of the formulas of Professor Rateau, and the action of the steam issuing from these nozzles when under high vacuum was directly observed. The result is shown by Fig. 7. The steam issuing from the mouth of the nozzle expands and contracts alternately, ultimately assuming a section of constant area. It was found that a number of these nozzles grouped together gave far better results than a single nozzle of the same throat area as the group of nozzles. The reason for this is to a large extent due to the fact that the alternate increasing and decreasing of the cross-sectional area of the steam stream is minimized by the contact of one steam stream with the next, when groups of nozzles are employed, and this helps considerably to increase the surface available for the entertainment of the air and gases. This entrainment is carried on mainly by friction, and it will be seen that if an appreciable amount of gas has to be dealt with, the frictional surface exposed to the gas has to be as large as possible. It is also inversely proportional to the density of the gas or fluid.

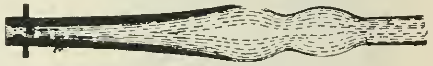
FIG. 7. BEHAVIOR OF FLOW

The number and size of the nozzles depends entirely on the space available in the diffuser, and keeping within the limits of workshop practice. The smallest number employed by the Mirrlees Watson Co. is three, each of which has a throat diameter of 1 mm. These are first-stage nozzles. On the largest size of pump, and in the second stage, the number of nozzles is 30, and these have a throat diameter of 5.2 mm. when using operating steam at 90 lb. per square inch.

Professor Leblanc, in his paper of 1911 to L'Association Technique Maritime, says that "the operating steam entrains the air by friction. During entrainment it is the velocity of the steam which is utilized, and not its kinetic energy."

Calling M the weight of operating steam used per second, V its velocity at the outlet of the nozzles, m the weight of air drawn in per second, and W the velocity of the mixture of air and steam, then

$$MV = (M + m)\ W$$

The ratio of the kinetic energy, $\frac{mW^2}{2}$, of the air drawn in to the kinetic energy, $\frac{MV^2}{2}$, contained in the operating steam as it comes out of the nozzles can therefore be stated as

$$\frac{mW^2}{MV_1^2} = \frac{mM}{(M + m)^2}$$

so that when $\frac{m}{M} = 1 \quad \frac{1}{2} \quad \frac{1}{3} \quad \frac{1}{4} \quad \frac{1}{5}$

$$\frac{mM}{(M + m)^2} = 0.25,\ 0.222,\ 0.187,\ 0.160,\ 0.139$$

This shows that if the utilization of the kinetic energy is to be the basis of the design, then for maximum efficiency it is necessary to bring the ratio $\frac{\text{air dealt with}}{\text{operating steam used}}$ as near to unity as possible.

M. Leblanc continues: "We tried to diminish the loss of kinetic energy by producing at the entrance of the diffuser a higher vacuum than was necessary, so that the fluid drawn in came in contact with the operating steam with a considerable velocity. If the efficiency of the diffuser could be brought almost to unity, we could add considerably to the over-all efficiency, but this has been found to be impracticable. Following on this, it was suggested to use puffs of steam after the manner of steam coming out of locomotive chimneys, but the complications involved in making arrangements for stopping the inlet of air during each puff were such that it would have been easier to use a centrifugal compressor. Afterward we tried to compensate for the bad efficiency due to frictional entrainment by transforming heat into kinetic energy in the nozzles. Superheating the operating steam, although so useful for turbine work, is, however, not good for an ejector, because it is more difficult to effect compression in the diffuser, which outweighs the advantages obtained in the nozzles. The next scheme was to use hot water in the nozzles, but this also proved unsuccessful."

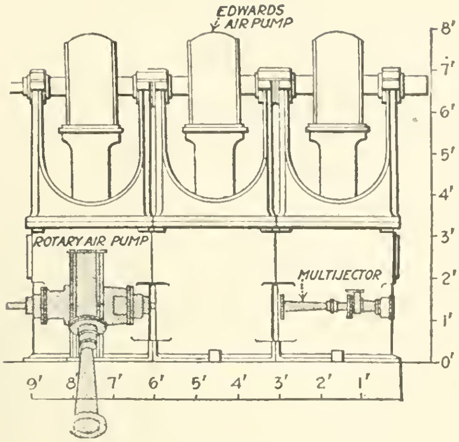

FIG. 8. COMPARATIVE SIZES

After numerous other trials it was decided that entrainment by friction was most economical, and various types of diffusers and different groupings of nozzles were experi-

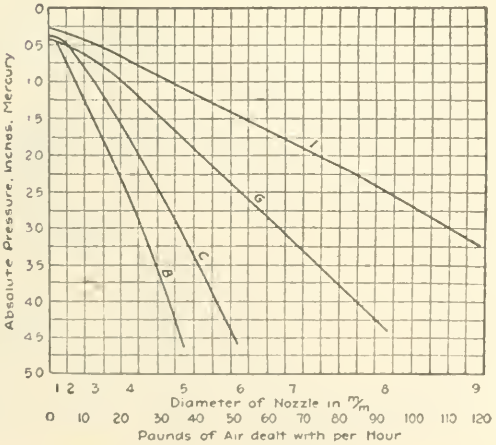

FIG. 9. CAPACITIES

mented with, until the present ejector, as shown in Figs. 5 and 6, was decided to be the most suited for condenser work. To go through the various stages in detail which led up to this design would take up too much time. With the form of ejector adopted it has been found that the efficiency of the nozzle is on an average 85 per cent., while that of the diffuser is 70 per cent. It will be seen that this ejector agrees very well with the ideal ejector which Professor Leblanc had in his mind. The first stage, which consists of a small group of nozzles, serves a triple purpose, inasmuch as it effects a certain amount of compression, heats up the entrained air, and gives it considerable velocity, and consequently an increase in momentum. The second stage has a large number of nozzles, and it is here where the major portion of the work is done, the air being compressed from approximately 26 in. vacuum up to something more than atmospheric pressure. To be more accurate, the steam used in the first stage is about 5 per cent. of the total.

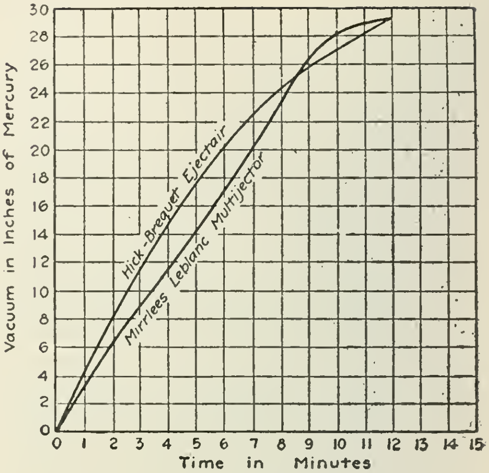

FIG. 10. TIMES REQUIRED FOR STARTING

In support of the fourth advantage which this air pump is supposed to possess, the following figures were obtained on the French torpedo-destroyer "Boutefeu." The turbines were stopped, but steam was on the glands. The volume to be evacuated was about 635 cu. ft. After 1 min. the vacuum was 6 5-16 in., 2 min. 15 in., 3 min. 22 13-16 in., 4 min. 25 9-16 in., 5 min. 26¾ in., and 6 min. 27 9-16 in. The theoretical vacuum corresponding to the tem-

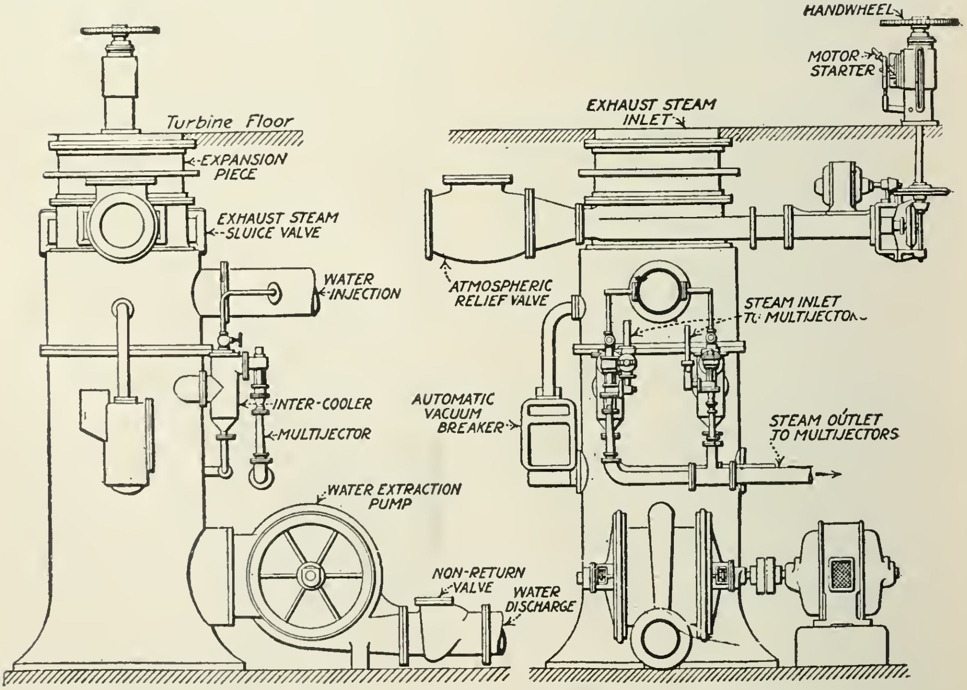

FIG. 11. MULTIJECTORS AT SCOTTISH CENTRAL POWER CO.

perature of the water, 67.1 deg. F.; namely, 28¼ in., was attained in 11 min. It was also arranged later to allow certain known air leakages to enter the condenser. With a 5-mm. nozzle, which passes 36.2 lb. of free air per hour, the vacuum dropped only ⅜ in. With a 15-mm. nozzle, which is equivalent to 326 lb. of air per hour, the vacuum was 21¼ in. With an inch cock full open it took 11 min. for the vacuum to fall to 12¼ in., at which figure the mercury column remained steady. On closing the regulating valve below the nozzle, the vacuum at once rose and attained the maximum almost immediately. There is a central station near Glasgow where this type of apparatus is at work with a multijet condenser. Sometimes when changing machines there is liability partially to lose the water for a minute or so, but none of the staff ever have to trouble about the ejectors, and as soon as the water comes back again the vacuum at once builds up, and the set is never shut down through failure of the air pumps. As a matter of fact, in the case above stated, it is highly probable that during the period that the water supply to the condenser is very small there is an air passage between the water spaces of the other condensers in the station and the multijet plant which would allow of a very excessive quantity of air getting into the condenser on load. This also shows that stability, the sixth claim, is another salient point. That high vacuum can be obtained is proved by the fact that this apparatus is now being used in the French Navy and mercantile marine, as well as on some land installations for refrigerating purposes, and installations are at work where the maximum vacuum obtained is within 1 mm. of the barometer. For condensers the best results yet obtained by the French Westinghouse company are within 5mm. of the barometer.

From the foregoing it would appear that this type of air pump is ideal for use on board ship, and particularly in the navy, where space is so valuable and weight of such consideration, and to illustrate this point Fig. 8 has been produced, and represents to the same scale an Edwards air pump, Leblanc rotary air pump, and Leblanc multijector for a steam duty on a surface condenser of 40,000 lb. per hour, water at 60 deg. F., vacuum 28½ in., and barometer 30 in. The weights are approximately 20, 832 lb., 4,480 lb., and 97 lb., respectively. For land work it is equally suitable, and will soon supersede the rotary pump in

OFFICIAL TEST OF NO. 18 M. J. CONDENSING PLANT WITH MOTOR-DRIVEN WATER-EXTRACTING PUMP, 1-SIZE "G" AND 1-SIZE "I" MULTIJECTOR AIR PUMP INSTALLED AT THE SCOTTISH CENTRAL ELECTRIC POWER COMPANY, LIMITED, BONNYBRIDGE

Duty—50,000 lb. steam per hour.
Vacuum—28.5 in. (barometer 30 in.).
Injection water—3,800 gallons per minute, temperature 65 deg. F.
Air pump capacity—84 lb. air per hour with guaranteed vacuum and water temperature.
Large ejector to operate condenser alone on loads over one-third and up to two-thirds full load.
Small ejector to work alone on loads of one-third full load and under.
Both ejectors to work on loads over two-thirds full load.

	Load				Vacuum			Steam Press. on Ejectors			Injection Water		Extraction Pump			
	Volts	Amps.	P.F.	Kw.	Turbo	Condr.	Barometer	"G"	"I"	Steam Press. on Turbine	Inlet	Outlet	Press, Gage	Amps.	Volts	R.P.M
8.45 p.m.	6,350	130	0.75	1,070	28.1	28.2	29.8	120	Shut off	152			5	58/60	440	480
11.0 a.m.	6,350	266	0.7	2,000	28.5	28.5	29.66	122	130	152	43	70.0	4	60	440	480
12.0 m.	6,350	280	0.7	2,152	28.6	28.5	29.63	122	125	152	43	70.0	4½	59	440	480
12.5 p.m.	6,400	270	0.7	2,090	...	28.2	29.63	Shut	125	152	43	70.0	4½	59	440	480
2.15 p.m.	6,400	325	0.75	2,700	28.2	28.25	29.59	125	160	150	43	72.5	5	62½	440	480
2.45 p.m.	6,450	345	0.76	2,970	28.2	28.3	29.59	125	157	157	43	72.5	5	62½	440	480
3.0 p.m.	6,500	280	0.74	2,330	28.2	28.4	29.6	122½	160	153	43	65.5	4	62½	440	480
3.30 p.m.	6,500	230	0.7	1,182	28.5	28.5	29.6	120	150	154	43	65.5	2	23	440	480

TESTS AT SCOTTISH CENTRAL

many power stations. For sugar refineries, chemical and other allied works it should prove exceptionally attractive and take the place of many reciprocating dry air pumps.

It may be advisable to point out here that this pump is purely a dry air pump, so that for surface condensers an additional water or condensate pump is still required, and for jet plants the usual extraction pump.

Fig. 9 shows the air-dealing capacity of various sizes of multijector pumps taken from the actual tests. The maximum vacuum in each case is equivalent to the theoretical, the slight difference at the origin of the curves being due to the different test conditions.

The table of tests, I, is taken from a plant installed at the Scottish Central Power Station at Bonnybridge at a date six months after the plant was put on commercial load. This company has just decided to order another plant, and has specified Mirrlees-Leblanc multijector air pumps.

Fig. 10 shows the time taken to start up a Hick-Breguet *ejectair* and a Mirrlees-Leblanc multijector.

Fig. 11 shows installation of multijector air pumps at Scottish Central Electric Power Co., Bonnybridge.

DISPLACEMENT TANKS FOR METERING COMPRESSED AIR

BY WALTER S. WEEKS

The following, which has originally appeared in *Mining Press*, describes an arrangement not essentially new, it having been shown in Compressed Air Magazine, August, 1912. It appears here with improvements in detail, and the description also will be found more practical and specific.

The general principle of displacement-tanks for measuring the air-consumption of rock-drills is known to most engineers, but it takes a good deal of experimenting to construct them so that they will work properly. It is hoped that these few suggestions will be helpful.

The elements of the displacement-tanks are two closed tanks connected with a pipe at the base and equipped with valves so that air may enter one while leaving the other. The air in the two tanks is always separated by a piston of water, which flows back and forth from one tank to the other. The change in level of the water in one tank multiplied by the area of the tank is the volume of air that has flowed out.

It will occur at once to the reader that there are two possible ways of measuring the volume of air displaced. In the first method we place on one tank a gauge-glass that reaches from the top to the bottom. We can read the gauge-glass at the start and after a given elapsed time, say, a minute, read it again. From these readings we can compute the flow of air per minute. The main drawback to this method is that the tanks must be perfectly regular from top to bottom, or else the volume must be calibrated in many places.

In the second method we place two small gauge-glasses on one tank, one at the top and one at the bottom, and find the volume between two marks on the glasses. If we take the time for the water to rise from the lower mark to the higher with a stop-watch, the volume flowing per minute can be calculated. With this type of meter, tanks of any shape can be used.

The air entering the tanks must do so at constant pressure. A reducing-valve is needed. I have tried many kinds and the most satisfactory one is comparatively inexpensive. It is made by the Westinghouse Air Brake Co. and is known as the S 4 locomotive governor. The price is $21. It should be fitted with a hand-wheel so that it may be regulated easily. It should be arranged as shown in Fig. 1 (*a*). (All references will be to Fig. 1 unless otherwise specified.) The control-pipe *b* should not be connected to a tank because the valve continuously exhausts air to the atmosphere. A lubricator *r* should be placed on the control air-line feeding very thin oil to the valve.

The air, after passing the reducing-valve, must enter first one tank and then the other and when it is entering one it must be leaving the other. These operations require a four-way valve. The stock four-way valve is costly and generally leaks. An excellent four-way valve can be made with four single valves *c* arranged as shown, with levers, so that they can all be thrown together. The valves are made by the Westinghouse company and are known as 1-inch cut-out valves. They cost $1.80 each. In the pipe *d* connecting the tanks at the bottom should be placed a quick-closing gate-valve *e*. It is necessary to measure the volume of but one tank. Glancing at Fig. 1, place a mark on the gauge-glass *f* and fill with

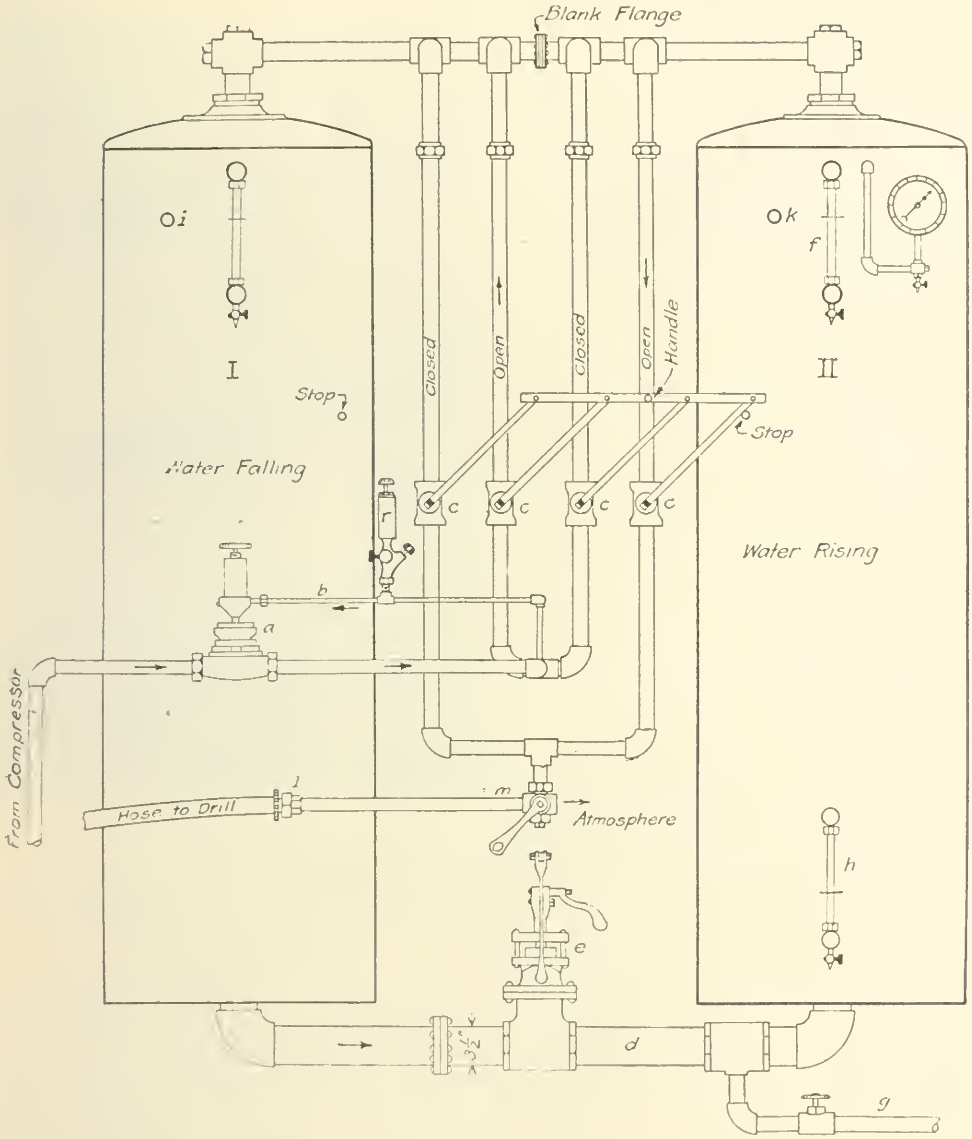

FIG. I

water to that point through the pipe *g*. Close the gate-valve. Draw off water through the pipe *g*, carefully measuring it until it comes in sight on the glass *h*. Now draw carefully until an even number of cubic feet is reached and mark point on the glass *h*. When the water in tank II rises from the lower mark to the higher, the measured volume of air has been displaced.

To obviate the necessity for watching the gauge-glasses I have arranged for a bell to ring at the two critical points. It is done by fitting up spark-plugs so that a contact is made between the tank and the sparking point of the plug by means of a float. The principle is shown in Fig. 2. An ordinary automobile-plug fitted with a float is tapped in at *i*. A plug built as shown in the drawing is placed at *k*. The plug is so constructed that the point of ringing can be controlled by screwing the centre point in or out. The plug *k* is placed on a line with the mark on the gauge-glass. A water-glass should be placed opposite the plug *i*, as shown.

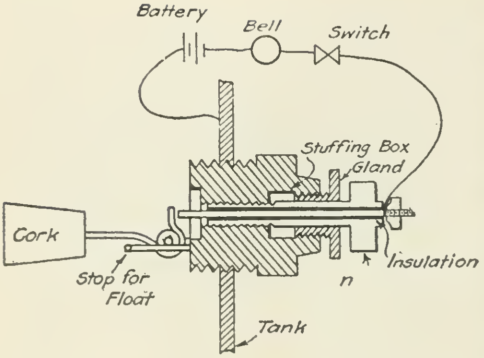

FIG. 2

To put the apparatus in working order the water is run up in tank I until the bell rings. The gate-valve is closed and the water in tank II is brought to the lower mark. The gate-valve is then opened and the water is forced to the upper mark. The gate-valve is again closed and the spark-plug *k* adjusted by turning the nut *n* (Fig. 2) until the bell rings at this point. Thus it is seen that between two ringings of the bell the measured volume of air has flowed out. The time is taken with a stop-watch.

To test a drill, connect the hose at 1 and start the drill running. Run water into tank I until the bell rings. Throw the valves and while the water is falling to the level of the spark-plug *i* adjust the reducing-valve. Start the stop-watch when the bell stops ringing and stop it when the bell starts again by contact being made at *k*. To hold the pressure constant the reducing-valve must be changed slightly owing to the small change in hydraulic head on the air. A run of any duration may be made by throwing the valves at each ringing of the bell and keeping account of the number of throws.

The volume between marks on tank II should be about 16 or 18 cu. ft. for ordinary drill-testing. Means should be provided to exhaust the air in the tanks to the atmospheric pressure if necessary. In the tanks shown in the drawing it is accomplished by a three-way valve at *m*. Charts may be plotted for different gauge-pressures with time in seconds between bells, against free air per minute.

The demand for gas in New York city is running 23,000,000 cu. ft. in excess of a normal day's consumption in other years.

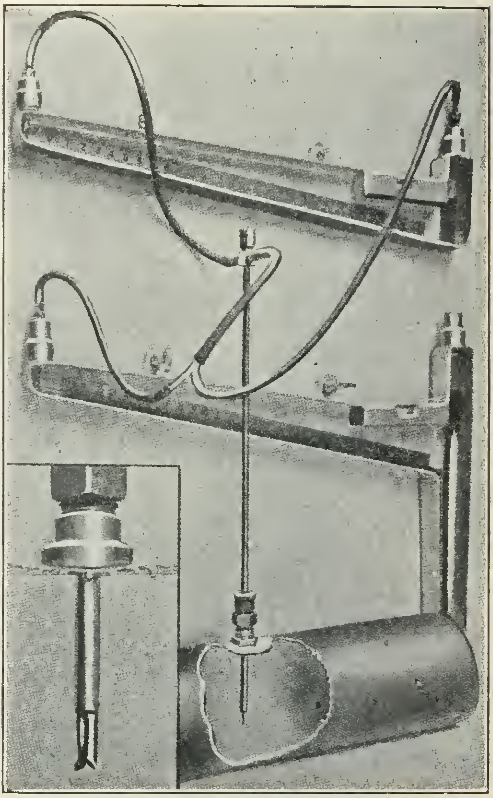

FIG. I. DETAIL OF PITOT TUBE AND METHOD OF ATTACHMENT TO PIPE

MEASURING AIR AND GASES WITH THE PITOT TUBE

BY A. H. ANDERSON*

The pitot tube is now generally understood by engineers, but its application has been restricted to research. Perhaps the reason the pitot tube has not received the attention it deserves in the industrial trades, for metering air and gas, is because recording instruments are available. Recording meters are desirable, but there is still a wide field in which an inexpensive device must be used. For instance, in distributing costs of gas or air among various departments, an indicating pitot tube may be placed in each branch and practically the same information obtained as with an elaborate instrument. In the air supply duct to a foundry cupola or a set of forges, the proper quantity of air can be gaged with a pitot tube and maintained during the period of operation.

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The pitot tube is easily changed from place to place, and the pressure or velocity of air may be gaged at different points along an exhaust line where the size of duct changes with the number of branches admitted.

The indications of the pitot tube are made readily available by the use of the tables given in this article by means of which calculations are avoided. They apply to air at approximately atmospheric pressures and also to gases of various densities, such as illuminating, coke oven, blast furnace and natural gas. In order that these tables may be applied directly, the coefficient of the pitot tube must be 1.00. If the coefficient of the pitot tube is 0.8, then the tabular value for velocity must be multiplied by 0.8. The pitot tube in Fig. 1 has a coefficient of 1.00.

An illustration of the proper method of connecting a pitot tube to the indicating differential gages is shown in Fig. 1. The liquid used in the gages is a mineral oil of 0.834 specific gravity and the color is red to make it conspicuous. The scale attached to the gage is graduated to read in inches of water. The dynamic (or bent) tube is in communication with the left-hand end of the upper gage. The static (or beveled) tube is in communication with the right-hand end of the upper gage and the left-hand end of the lower gage. Therefore, the upper gage indicates the "velocity pressure" and the lower gage indicates the static pressure.

The velocity corresponding to the "velocity pressure" may now be determined by reference to the tables. Temperature, static pressure and humidity affect the velocity, but within certain limits the static pressure and humidity may be neglected.

Table I, shows the velocities of air at 80 deg. F., corresponding to various "velocity pressure" readings, in inches of water.

Table II, shows the coefficient by which the velocities in Table I may be multiplied when the air is of any other temperature than 80 deg. F. Coefficients are also given in this table for gases of various densities.

In certain cases where the pitot tube is placed in a long straight pipe, it may be assumed eddy currents are absent, and the tip of the pitot tube may be located at a distance from the center equal to 0.8 of the actual radius, in order to obtain average results. In most cases there are conditions which deflect the air currents in the pipe, and the maximum velocity is found at one side of the center. Un-

TABLE I. AIR VELOCITIES CORRESPONDING TO VARIOUS VELOCITY PRESSURE READINGS

Air at 80 deg. fah.; 100% humidity; 29.5 in. Barometer.

Vel. Press. Inches.	Ft. per min.	Vel. press. Inches	Ft. per min	Vel. press. Inches	Ft. per min	Vel. press Inches	Ft. per min
.01	409	.50	2,890	.99	4,070	1.48	4,976
.02	579	.51	2,920	1.00	4,090	1,49	4,993
.03	710	.52	2,950	1.01	4,110	1,50	5,010
.04	818	.53	2,980	1.02	4,130	1,60	5,180
.05	914	.54	3,000	1.03	4,150	1,70	5,330
.06	1,000	.55	3,030	1.04	4,170	1,80	5,490
.07	1,080	.56	3,060	1.05	4,190	1,90	5,640
.08	1,155	.57	3,090	1.06	4,210	2,00	5,790
.09	1,227	.58	3,115	1.07	4,230	2,10	5,930
.10	1,295	.59	3,140	1.08	4,250	2,20	6,080
.11	1,355	.60	3,170	1.09	4,270	2,30	6,210
.12	1,418	.61	3,200	1.10	4,290	2,40	6,330
.13	1,475	.62	3,225	1.11	4,308	2.50	6,480
.14	1,530	.63	3,250	1.12	4,327	2.60	6,600
.15	1,585	.64	3,275	1.13	4,345	2.70	6,720
.16	1,635	.65	3,300	1,14	4,364	2.80	6,850
.17	1,690	.66	3,325	1,15	4,382	2.90	6,970
.18	1,735	.67	3,350	1,16	4,401	3.00	7,090
.19	1,785	.68	3,375	1,17	4,419	3.10	7,200
.20	1,830	.69	3,400	1,18	4,438	3.20	7,320
.21	1,875	.70	3,425	1,19	4,456	3.30	7,430
.22	1,920	.71	3,450	1,20	4,475	3.40	7,540
.23	1,960	.72	3,475	1,21	4,493	3.50	7,660
.24	2,005	.73	3,500	1,22	4,512	3.60	7,760
.25	2,050	.74	3,525	1,23	4,530	3.70	7,870
.26	2,090	.75	3,550	1,24	4,549	3.80	7,970
.27	2,125	.76	3,570	1,25	4,567	3.90	8,070
.28	2,160	.77	3,590	1,26	4,586	4.00	8,180
.29	2,200	.78	3,615	1,27	4,604	4.10	8,280
.30	2,240	.79	3,640	1,28	4,623	4.20	8,400
.31	2,275	.80	3,660	1,29	4,641	4.30	8,480
.32	2,310	.81	3,680	1.30	4,660	4.40	8,580
.33	2,350	.82	3,700	1.31	4,678	4,50	8,670
.34	2,390	.83	3,720	1.32	4,698	4.60	8,770
.35	2,420	.84	3,740	1.33	4,714	4.70	8,870
.36	2,455	.85	3,765	1.34	4,732	4.80	8,970
.37	2,485	.86	3,790	1.35	4,750	4.90	9,060
.38	2,520	.87	3,810	1.36	4,768	5.00	9,140
.39	2,550	.88	3,835	1.37	4,786		
.40	2,590	.89	3,860	1.38	4,804		
.41	2,620	.90	3,880	1.39	4,822		
.42	2,650	.91	3,905	1.40	4,840		
.43	2,680	.92	3,925	1.41	4,857		
.44	2,710	.93	3,946	1.42	4,874		
.45	2,740	.94	3,967	1.43	4,891		
.46	2,770	.95	3,988	1.44	4,908		
.47	2,800	.96	4,008	1.45	4,925		
.48	2,830	.97	4,029	1.46	4,942		
.49	2,866	.98	4,050	1.47	4,959		

TABLE II. VELOCITY COEFFICIENTS FOR VARIOUS TEMPERATURES

		GAS Lb. per cu. ft. at 80 deg.			
Deg. Fahr.	Air	.05	.055	.06	.065
50	0.972	1.160	1.111	1.060	1.020
60	0.980	1.170	1.120	1.070	1.030
70	0.990	1.180	1.130	1.080	1.040
80	1.000	1.200	1.140	1.090	1.050
90	1.010	1.210	1.150	1.100	1.060
100	1.025	1.225	1.170	1.115	1.075
110	1.038	1.245	1.185	1.130	1.090
120	1.049	1.256	1.195	1.143	1.100
130	1.060	1.270	1.210	1.155	1.111

der these conditions, it is necessary for accurate results to determine the average velocity by making a traverse of the pipe with the pitot tube. This can be done in the following manner: Determine the actual radius of the round pipe and make a series of pitot tube observations at intervals from the center to the wall. The intervals between the readings are determined by the equation.

$$R = \frac{r}{\sqrt{N}} \sqrt{2a - 1}$$

Where R=distance of various positions from center of pipe, inches.
r=radius of pipe, inches.
N=number of readings desired from wall to wall.
a=order of readings from center.

The pitot tube is now located in turn at the positions as determined above, first, on one side of the center, and then on the other side. The velocities corresponding to the ten velocity pressures are taken from Table I, and the arithmetical average determined.

As an illustration, assume a round duct 10 in. diameter, the number of observations from wall to wall to be ten. In this case, "r"=5 in. "N"=10; "a" assumes values from 1 to 5. The values of "R" on one side of the center resulting from the substitution in the equation are as follows:

	Distance from center, inches
R_1	1.58
R_2	2.73
R_3	3.53
R_4	4.18
R_5	4.74

TABLE III. RESULTS OF TEST OF A 10-IN. PIPE

Distance from wall, in.	Distance from center, in.	Velocity pressure, in.	Velocity ft. per min.
0.27	4.73	0.105	1310
0.83	4.17	0.125	1450
1.50	3.50	0.145	1550
2.27	2.73	0.160	1630
3.42	1.58	0.165	1650
6.58	1.58	0.165	1650
7.73	2.73	0.160	1630
8.50	3.50	0.145	1550
9.17	4.17	0.125	1450
9.73	4.73	0.105	1310
		AVERAGE	1550

The positions on the other side of the center are duplicates of those given below. Actual velocity pressures and velocities from a test of a 10-in. pipe are shown in Table III, the corresponding curve being given in Fig. 2.

The pitot tube may now be permanently located in the pipe in either of the two ways described:

(1) Locate the tip of the pitot tube at the proper distance from the center of the pipe to obtain average reading; or

(2) Locate the tip of the pitot tube at the center of the pipe and multiply the indicated velocity by the ratio of the average to the center velocity.

Method 1. Figure 2 gives a curve showing the variation of velocity across one diameter of a round pipe. This curve is drawn from the test data in Table III. The average velocity is 1550 ft. per min., and the maximum velocity (or velocity at the center), is 1650 ft. per min. The average velocity is found at a distance of 4.2 in. from the center, and if the tip of the pitot tube is located at that point the readings obtained from the gages give average results.

Method 2. The ratio of average velocity to maximum velocity is $\frac{1550}{1650} = 0.94$. If the tip

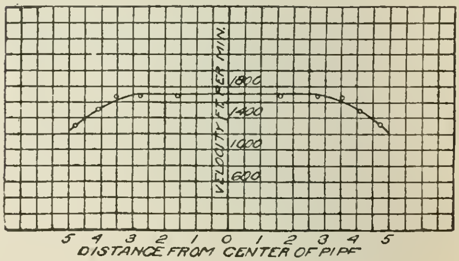


FIG. 2

of the pitot tube is located at the center of the pipe the indications of the gage give the velocity at the center, which multiplied by the ratio gives the average velocity.

The foregoing methods involve preliminary work in order to obtain the proper setting of the pitot tube: but this must be done in any event, whether the apparatus is of the inexpensive type or of the most elaborate design.

The method of computing the proper intervals between pitot tube readings in the average velocity determination may be replaced by the graphical method which is shown in Fig. 3.

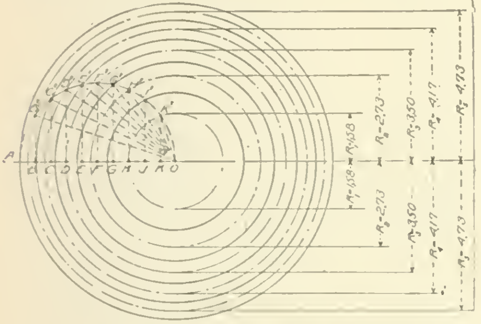
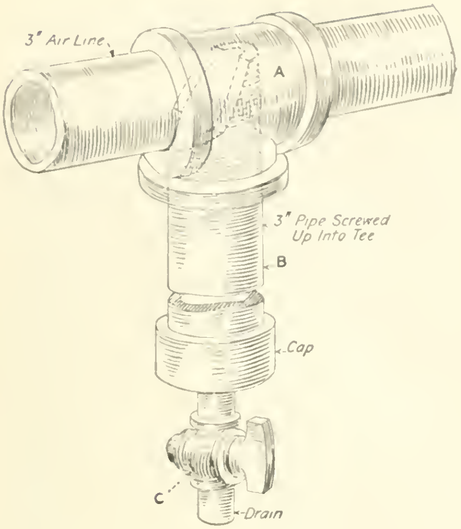


FIG. 3. GRAPHICAL METHOD OF COMPUTING AVERAGE VELOCITY

The large circle represents the round pipe. Upon the radius is constructed a semicircle. The radius of the large circle is divided into as many equal dividends as there are to be pitot tube readings. Erect perpendiculars from each point and through the intersection of each perpendicular and the circumference of the semicircle construct circles with the same center as the large circle. The radius of the inner ring is OJ′, while the radius of the mid-position for the pitot tube is OK′. The construction of Fig. 3 is for the case of the 10-in. pipe mentioned earlier in this article. To obtain a complete traverse of a diameter of the pipe, set the pitot tube at each of the radii proceeding from one wall to the other.

It will be observed that great stress has been laid on the importance of obtaining accurate values for average velocity. This is necessary because local conditions distort the air currents in a pipe and each individual application must be examined by itself.

The internal diameter of the pipe must be carefully measured and the cross-sectional area calculated in square feet. The product of the area and the average velocity is the volume of gas or air moved per minute.



WATER TRAP FOR AIR LINE

DRAINING THE AIR LINE

BY W. B. LAILER

We experienced considerable trouble in the operation of pneumatic chipping hammers at points distant from the source of air supply, due to the presence of water of condensation in the pipe lines, which was discharged through the exhaust ports of the hammers. To eliminate the presence of water in the air before its entrance to the hose line we devised a separating device, which served its purpose admirably. A tee *A* was placed in the pipe line at a point adjacent that at which the hammers were operated. Into this tee was connected a depending piece of pipe *B*, capped at its lower end, forming a reservoir, or well. A drain *C* was provided for removing the water of condensation. This device helped greatly to remedy our trouble, and made unnecessary the use of expensive heating equipment for drying the air.—*American Machinist.*

[The last sentence above may be slightly misleading. Merely heating the air does not dry it, in the sense of removing the moisture, and when the temperature falls the air will be just as "wet" as before. Draining the line by any device that may be employed is always to be regarded as correct practice, but the condensation and precipitation of the moisture previous to the draining is accomplished by the cooling of the air under pressure, rather than by heating it.]

TEMPERATURE-SENSITIVE PAINTS*

The above term has been applied to chemical compounds that are subject to color changes at a comparatively small rise in temperature. These paints are occasionally used for indicating a dangerous rise in the temperature of machine bearings, electric generators and other apparatus where excessive heating has to be avoided. The two compounds described below are easy to make and reliable in operation.

NO. 1—DOUBLE IODIDE OF MERCURY AND COPPER

This compound is normally red, but turns black at about 87 deg. C, (188.6 F.) becoming red again when the temperature falls.

To prepare this paint make separate solutions of copper sulphate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the precipitate which is first formed is re-dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) and the red double iodide of mercury and copper will be precipitated. Wash and dry this precipitate on filter paper. The red powder may be mixed with a weak solution of gum arabic in water and used as a paint.

NO. 2—DOUBLE IODIDE OF MERCURY AND SILVER

This compound is normally of a light primrose yellow, but turns to a dark orange or brick red at about 45 deg. C, (113 F.) It becomes yellow again on cooling—and it may be heated and cooled an unlimited number of times without losing its curious property, providing it is not overheated.

Make separate solutions of silver nitrate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the original precipitate is dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) which will produce a precipitate of the double iodide of mercury and silver of a bright yellow color. Wash and dry the precipitate on filter paper. It can be used as a paint by mixing with a weak solution of gum arabic in water.

[It will doubtless occur to some of our readers that these paints could be of service in compressed air practice. For instance, spots of paint No. 2 on the eduction pipes of intercoolers and aftercoolers would become telltales at once if the air were not sufficiently cooled. If there were no aftercooler then spots of paint No. 1 at intervals along the pipe line, and then spots of No. 2 as the distance increased, would show the cooling of the air in transmission. When the normal color returned to the latter spots the air would have given up a large portion of its moisture, which should then be separated and drawn off.—Ed. C. A. M.]

WASHING AIR FOR ELECTRIC SERVICE

Air washing and cooling are often resorted to for one or several reasons, any one of which may be the predominating reason for its adoption in a specific instance, but all of which deserve consideration at this time of heavy loads long sustained with a shortage of capacity. Washed air, as its name implies, is air that has been washed and being washed is comparatively clean. Clean air reduces the dirt carried over into air-cooled machines, reducing the clogging up of air ducts and vents which interfere with heat transfer and reduces the volume of cooling medium. Moreover, the growth of such materials as dust and dirt increases the fire hazards as these accumulations are readily ignited by flame or arc within the machine. Cooling the air, which occurs during the process of washing or cleaning, enables an increased load to be carried for definite temperature rise of the machine, since temperature drop or gradient between maximum operating temperature and ambient temperature of cooling medium is a factor in heat transfer. Air washing increases the capacity because of the cooling and also because of the reduced amount of foreign matter carried into the machine; and also permits a unit to remain in service longer without being taken out of service for cleaning. Moreover, troubles due to grounds and breakdowns usually are reduced because of the comparative absence of dirt and dust. Washing the air increases capacity, reduces fire risk, decreases labor and enables a unit to remain in service a greater percentage of the time. Air washing may at this time therefore prove a convenient solution to those hard-pressed for capacity, where the load exceeds the capacity and units can be ill-spared for cleaning.—*Electrical Review.*

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*By W. S. Andrews, Consulting Engineering Department, General Electric Company, in General Electric Review, Feb., 1918.

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THE SUBMARINE AND THE UNSINKABLE SHIP

The submarine is unique in history. This terrific aggregation of inventions, having its birthplace in America, God forgive us! whose sole function is destruction, is at once the most potently and malignantly effective of all. In any comprehensive view of the war, in any attempt to forecast the outcome, it is the one active agency which it is impossible to ignore. Its record of destruction has nothing with which to compare it in all history, and the end is not yet.

We are not forgetting the airplane, nor how the hopes and the fears of the world now concentrate upon it, but it is not pertinent to our present purpose to consider it.

In the employment of the submarine, as we all know, a most peculiar situation has developed, in that it can only be largely employed by one of the two parties arrayed against each other in the great war. Its sole function is to sink ships, and not warships at that, but chiefly those employed in carrying foodstuffs, munitions and fighting men across the seas. But it so happens that the Central Powers have no ships at sea to be destroyed, so that they have practically everything to gain and nothing to lose by the employment of the submarine.

The problem thus forced upon the Allies is to sink or disable the submarines when they can, to avoid or dodge them also when they can, but more especially to so design or so arrange their ships internally that they cannot be sunk by a torpedo. Curiously enough, any inventions toward these ends cannot be in the least available to the submarine gang, for they have no ships abroad to be saved from sinking. Any information concerning the means adopted for making the ships unsinkable cannot be of any use or value to the Central Powers, and can, in fact, have no effect at all upon them except in so far as it may show them how the task which the submarines have undertaken becomes more hopeless. Only discouragement and not encouragement at all can be in it for them, nor anything to help their hellish schemes.

On the other hand, as one thing leads to another nowhere more surely and more constantly then in the line of practical invention, all possible up to date information concerning the inventions which are developing in this line must have a stimulating effect and exert an impelling force upon the brains now trained upon the problem of the unsinkable ship, and we may be now and always only certain that further important advances are inevitable in consequence of the revelations.

We have not at all to seek the means of rendering ships unsinkable, but only the manner of application. As sunken ships are now frequently raised by the use of air, it must be in the nature of things a still simpler thing to prevent them by the same means from sinking, and thousands have proposed it.

The scheme of Mr. W. W. Wotherspoon, which has been applied to ships of the U. S. Navy, provides in the design of the ship for many hundred separate watertight, air filled compartments, only a few of which are liable to rupture from any local injury to the ship.

And now comes Mr. William T. Donnelly, Member of the Society of Naval Architects and Marine Engineers, and an acknowledged expert on flotation, with his system of buoyancy boxes. In the ship Lucia where they are placed there are nine or ten thousand of these boxes. They are normally of ordinary pine, 3 ft. long, 2 ft. wide and 1 ft. deep, and to secure water-tightness they are covered with galvanized sheets These boxes are fitted in lines around the ship, both above and below the water line, and fastened to beams where vacant space is available. Boxes also of larger size and of different shape are used in adaptation to available space. In stowing merchandise in ships, boxes of the same kind may be inserted as space fillers any where. The idea apparently has more of common sense then of ingenuity in it, and is none the worse for that. Mr. Donnelly estimates that only 14 per cent. of cargo space is lost in making ships unsinkable by this means, and the cost of thus equipping vessels is put at 10 per cent. of the cost of the ship. No one can well dispute the fact that this device should be given a fair chance for full demonstration as quickly as possible, and in the meantime other devices of equal promise will be equally welcome.

Those who imagine that an aeroplane needs a 300 acre field in which to land will do well to remember that British pilots of the Royal Flying Corps and Royal Naval Air Service, and French pilots also, have flown regularly over the mountains in the Balkans, starting from and landing in little patches of level ground in the valleys.

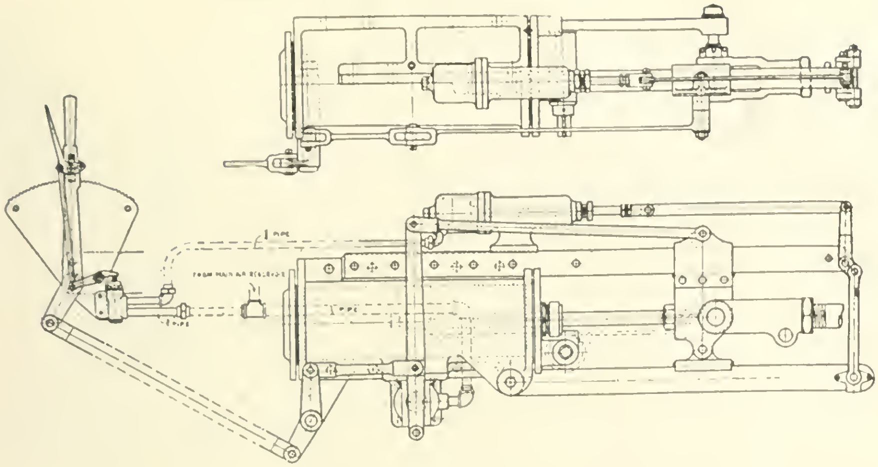
NEW BOOK

Finding and Stopping Waste in Modern Boiler Rooms, is an up-to-date handbook (copyright 1918) compiled by George H. Gibson, assisted by Percy S. Lyon, and published by the Harrison Safety Boiler Works, North Philadelphia Station, Philadelphia. There are 274 pages, 7 by 4¾ inches, liberally illustrated and the nominal price is $1.00. The book is prepared for those who have to do with steam plants, and while originally planned as an advertising publication the formal advertisements are conspicuous by their absence and practically the entire book is a useful compilation of the best information on the design and operation of steam boiler plants. The topics successively treated relate to fuel, combustion, and steam generation, while the uses of the steam, for the development of power, for heating or other purposes are not considered. Tables and charts are given, various references are cited and the contents are carefully indexed.

A PNEUMATIC LOCKING LOCOMOTIVE REVERSE GEAR

An excellent locomotive reverse gear designed by Mr. C. J. Mellin, consulting engineer of the American Locomotive Company, has been brought out by that concern and applied by them to a number of engines which they have recently turned out. The essential feature, or rather one of the principal component parts of the apparatus, consists of an ordinary cylinder with a cup-packed piston and a crosshead with a single guide bar, an operating valve, a locking device and a hand-lever with a latch valve in the cab. What looks like the bottom guide for the crosshead is really a pivoted bar, which may be drawn up at one end and in a sense clamped on the underside of the crosshead, and this really forms a clamp which locks the crosshead and prevents any creeping of the mechanism, due to leakage or from other causes. It is this outside or mechanical system of locking that forms one of the distinctive features of the Mellin gear.

A close inspection of this mechanism shows that the top guide is stationary, and the crosshead entirely encloses it, so that if the lower bar or clamp bar was to fall off it would make no difference to the straight line movement of the crosshead. The action of the clamp bar is simple but effective. On top of the apparatus



PNEUMATIC REVERSING GEAR

is placed what is called the locking device. It consists of a cylinder or case containing a spring at one end of which is a piston moving in a small cylinder which is formed as a continuation of the spring case. It may be said of this design that the locking device is of the friction variety, with the spring case combined with a release cylinder. There is a spring, and connected to the pivoted guide, which by the tension of the spring is magnified through a bell crank leverage, and this force grips the crosshead between it and the main guide. The hand lever latch or lock release valve is a simple poppet inlet and discharge valve, subject to the movement of the hand lever latch, by means of a trigger and bolted to the lever fulcrum bracket.

When the reverse mechanism is about to be used, the hand which grasps the lever puts the latch handle up against the main handle and this opens the small poppet valve, referred to above. Air therefore flows into the ⅜-in. pipe leading to the air end of the spring case. The air pressure so introduced moves the small piston and compresses the spring in its case. In consequence of this, the bolt from the spring case moves back and, through its connections, loosens the pivoted locking bar under the crosshead.

The hinged lock bar or guide must clear the pivoted shoe on the crosshead by ⅛ in. in its parallel position with the main guide, so that it takes an inclined position when locked; giving more inclination when the crosshead is at the inner end of the stroke, and any slight variation in leverage action which exists on the crosshead by the locking guide in and between these positions, is compensated for by the variations in tension of the locking spring, thus securing an approximately uniform locking pressure on the crosshead for any position of its stroke.

The operating valve, placed in the centre, below the cylinder, is of the rotary type, having lap and passages like an ordinary slide valve but without any stuffing box.

In raising the handlever latch in the usual way, the latch valve automatically admits air into the locking cylinder and releases the lock by compressing the spring and remains so until the latch is again dropped and the lock becomes set. The movement of the handlever transmits motion through the floating lever, shown vertically in central position in our illustration, with the crosshead connection to it as a fulcrum, and this movement opens the operating valve. The motion of the crosshead which follows, transmits motion through the floating lever with the handlever connection as a fulcrum, and closes the valve when the gear is stopped and gripped by the lock at the corresponding position of the handlever. At any movement in either direction of the handlever this action is repeated with all parts except the handlever.

In order to hold the valve gear without danger of undesirable movement, the locking guide is brought in contact with the pivoted shoe on the crosshead, the spring link is adjusted so that its connection to the bellcrank is about

¾-in. outside the vertical center line of its fulcrum and the length of the lifting links are adjusted so as to give a close but free insertion of all connecting pins in the lock.

This is a good example of the growing use of pneumatic reverse lever gears, now that the valve mechanism has become so that with any sort of motion of the engine the valve gear is hard to work. There is no such thing now as "horsing her over," as in former days, and a good, pneumatic reverse mechanism gives a much finer cut off than was possible with the old reverse lever and notched quadrant, however fine the notches were cut.—*Railway and Locomotive Engineering.*

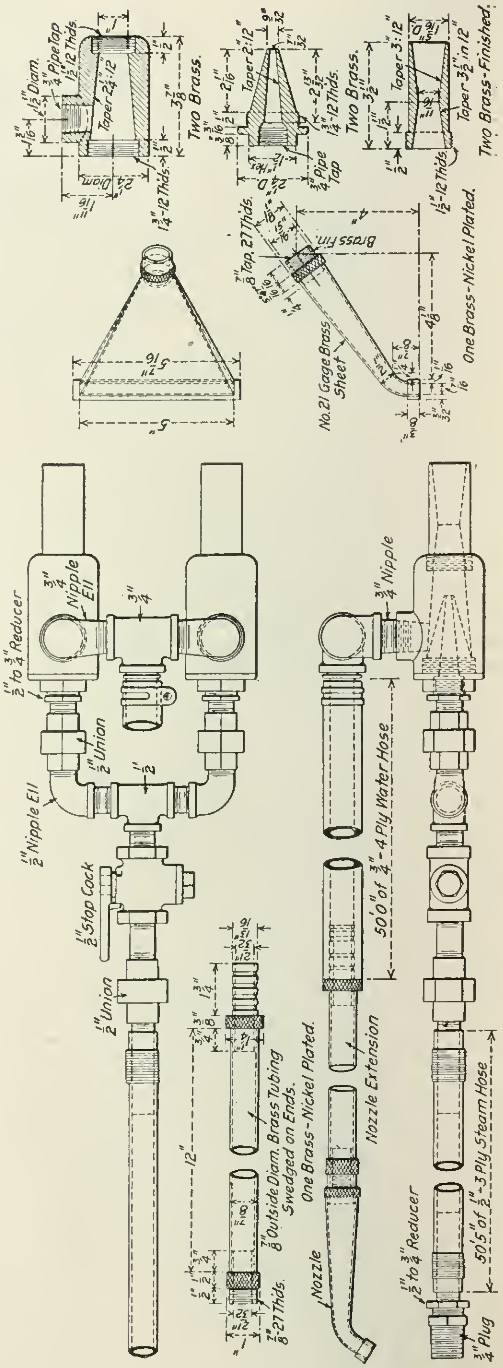
A COMPRESSED AIR OPERATED VACUUM CLEANER*

A vacuum cleaner is shown in the drawing which was developed on the Philadelphia & Reading. It has been in successful use on that road for about a year in cleaning passenger cars and offices at points where compressed air is available. The device is intended to be left on the platforms of cars and in the hall outside of office doors while in operation, a 50 ft. length of four-ply water hose being used to make this possible.

One of the difficulties which is experienced with many vacuum cleaners is that they become stopped up, especially in very damp weather, and are not easily cleaned out. It will be noticed that with this cleaner the vacuum chambers may be cleaned out very readily by removing the combining nozzles and turning on the compressed air. The vacuum gage registers about 18 in. when using the cleaner with air pressure at 100 lb. per square inch. Of course, a higher vacuum may be produced if higher air pressure is available.

Little need be said relative to the construction of the device, as the drawing clearly shows all the details. As developed on the Philadelphia & Reading, the parts are made of Brass, but there is no logical reason why cast iron can not be used if desired.

A. U. S. destroyer recently went into drydock after having steamed 25,000 miles, and then requiring only scraping and painting.



COMPRESSED AIR VACUUM CLEANER

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*By Howard W. Stull, Machine Shop Foreman, Philadelphia and Reading R. R., Reading, Pa., in Railway Mechanical Engineer.

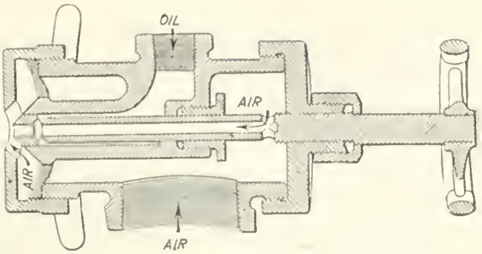
DISTILLATION OF LIGNITE

Efforts are being made in France to introduce the distillation of lignite for tars. The Societe de Distillation des Combustibles, Paris, is constructing an improved Ziegler type of furnace similar to that used for the distillation of peat, a type yielding about 7 per cent. of tar which is treated by fractional distillations carried out *in vacuo*, to increase the output of heavy products; followed by chemical purification by washing with dilute sulphuric acid and soda, to remove the picolines, cresols, etc. The crude paraffin, extracted by crystallisation of the heaviest oils, is first passed through the filter-press. The purification consists of a series of filterings in the filter-press, and meltings in light oil. The last traces of oil are removed by scrubbing with super-heated steam, and the paraffin wax is clarified by filtering through animal black. In one place in Germany, where the system was adopted, 70 to 80 per cent. of marketable products were obtained from lignite tar, viz., 15 to 20 per cent. of paraffin wax; 5 to 20 per cent. of kerosene; 5 to 15 per cent. of cresotes and organic acids; the remainder being light products, petrol, etc., or heavy products such as gas oils and lubricating oils.

A FUEL OIL BURNER

We illustrate here, both externally and internally, the Coleman oil burner made by the Foundry Equipment Company, Cleveland, Ohio. It is already numerously employed in foundries on melting furnaces, for core and mold ovens, annealing ovens, ladle heaters and wherever fuel oil is burned, and there is no apparent reason why it should not be as serviceable elsewhere as in the foundry.

In this burner the air supply is connected to the lower nozzle and the air is fed from the main air chamber through a hollow brass stem. The oil is fed around this circular stream of air, and, at the end of the brass stem which controls the oil supply the oil is forced into the stream at a sharp angle. This causes a breaking up of the oil into minute particles and produces a primary mixing with the air. A second and larger outer stream of air, cutting through the primary mixture, produces a further atomization and furnishes the proper combination of oil and air for complete combustion. The ease with which all adjustments are made is self-evident, the construction permitting the feeding of a very small or a large quantity of oil, as well as complete control over the supply of air for combustion.



SECTION OF COLEMAN OIL BURNER

The burner as here shown provides for a ½ in. oil line and a 2 in. air line, giving a large range of feed for both oil and air. Air at 2 lb. and oil at 5 lb. are quite commonly used, but these burners are in operation under a great variety of conditions as to both pressures.

A BLOWER FOR PRIMING CENTRIFUGAL PUMPS

One of the difficulties met with in the operation of a centrifugal pump is the priming, and for this reason a number of operators are using the plunger rather than the centrifugal type of pump. Various methods of priming have been tried, some of which were successful and others not. The Clearfield Bituminous Coal Corporation at its Rossiter mine, Rossiter, Indiana County, Pennsylvania, has succeeded in devising a priming device that has operated very successfully.

In the pumping room at the foot of the main slope (it is also at the foot of a manshaft) the company has three 600-gal. single-stage Morris centrifugal pumps arranged in a battery. These pumps have separate suction lines, but they all discharge into a main dis-

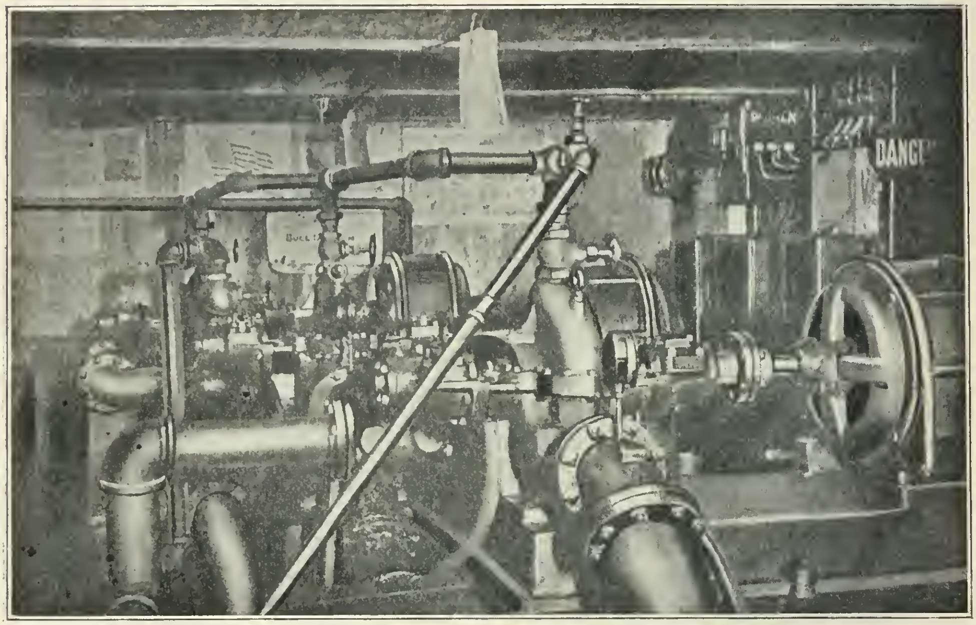


FIG. I. PUMPING ROOM

charge line that goes up the mainshaft to the surface, making a head of 80 ft. for the pumps to work against. The pumps have a maximum lift of 9.23 ft. on the suction line. The pump-room itself, as can easily be seen in Fig. 1, is built entirely of concrete.

The Clearfield company has had considerable trouble in operating these pumps. It has been difficult to prime them, as they would not start until there was 7 lb. pressure in the discharge line. First the plan was tried of keeping the water in the pumps from running back to the sump by means of foot valves, but these valves would stick and leak, and they caused a great deal of annoyance.

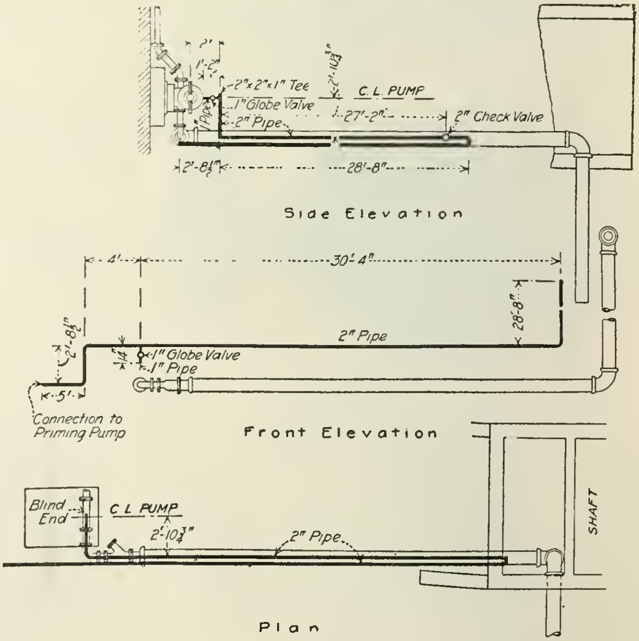


FIG. 2

Next priming was tried by means of an auxiliary pump, an electric-driven plunger pump built by Deming. The water was pumped into the centrifugal pump through the priming hole. Foot valves were placed on the suction pipes, and the plunger pump was run until the water filled the suction pipe and the pump, and rose 14 ft. in the discharge pipe. Then the centrifugal pump was started. This method was found to be too slow, particularly if there were bad leaks in the foot valves, though it is still used in case of emergency.

It was then decided that if a vacuum could be produced in the pump the water would rise from the sump into the suction pipe and then into the pump. This method was found to be successful and much quicker than the methods first tried. Further, it eliminates all trouble due to leaking foot valves.

A 2-in. pipe was connected by branch lines to each of the priming inlets of the pumps, as illustrated in Fig. 2. These branch lines each consist of a 1-in. nipple, a 1-in. globe valve and another 1-in. nipple. The main 2-in. pipe was run to the main shaft, 30 ft. away, and then up a distance of 28 ft. 8 in. This, together with the difference in elevation between the center of the pump and the 2-in. pipe line, makes a total distance of 31 ft. 4½ in., or higher than water will rise in a vacuum. A check valve was placed near the top of the line, and at the top of this pipe a 2-in. return elbow was located, then a 2-in. pipe was run down again to the pumproom, to which was connected a blower operated by a 2-hp. motor.

When it is desired to prime the pumps, the main discharge line valve is closed and the blower started. This sucks the air from the 2-in. pipe, the pump and the suction line, causing the water to rise in the suction pipe, the pump and the 2-in. pipe line. As soon as the water reaches a height of 14 ft., as indicated on a pressure gage at the bottom of the discharge line, the large centrifugal pump is started, the large valve in the discharge pipe opened and the water discharged through this to the surface.—*Coal Age.*

NOTES

To build a tunnel under the Mogi straits, Japan, starting at Shimonoseki and ending at Dairi Fukuoka Prefecture, is the intention of influential citizens of Fukuoka, Kiusha, who will form a company with capital stock of $7,228.250. This tunnel will be connected with the railway trunk line at Kiushu and will be 17,700 feet long. It will extend for 4000 feet beneath the sea and will require five years to complete.

Sugar, states a medical authority, is of all the foods the quickest source of energy, and almost the cheapest. Only the cereals in their coarsest form offer more nourishment for the same expenditure. In no other food has nature stored up nourishment in a form so near that which the human body can utilize it. A spoonful of sugar is actually transformed into body energy in half an hour and less. This quick efficiency has been found useful by athletes and by soldiers on forced marches. Pound per pound, sugar gives a higher fuel value or working power to the muscles than do beans or peas or the cereals when sold in the breakfast food forms.

It is reported that the Gotha airplanes which raid England from time to time, are equipped with apparatus for producing smoke clouds for purposes of concealment. The smoke cloud is usually emitted when the raiders are threatened by anti-aircraft artillery; and since it has the same color and formation as the fleecy clouds overhead, the task of the gunners below is made far more difficult.

Production records at the Baldwin Locomotive Works are being broken weekly. It is reported that in a recent week about 100 locomotives of various sizes were turned out, and President Alba B. Johnson is authority for the statement that the plant is completing a locomotive an hour.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 1

1,251,501. PNEUMATIC ACTION. Charles G. Gilberg, Rockford, Ill.

1,251,641-2-3. SLACK-TAKE-UP FOR FLUID-PRESSURE BRAKE SYSTEMS. George Christtenson, Jamaica, N. Y.

1,251,673. AIR-OPERATED TOY. Charles Koshalko, Cleveland, Ohio.

1,251,734. PNEUMATICALLY-CONTROLLED FRICTION DRIVING MECHANISM FOR IRONING-MACHINES. Fritz Balzer, Chicago, Ill.

1,251,653. STUMP-BURNER. Albert S. Goodwin and Charles C. Hurd, Tacoma, Wash.

1. A stump burning device comprising a blast pipe adapted to enter a hole formed in the stump, means for inducing a draft of air in said pipe, and means for reversing the direction of said draft.

1,251,849. COMPRESSED-AIR-POWER PLANT. Seward S. Vernon, Paterson, N. J.

1,251,954. PROCESS FOR PRODUCING LIQUID OR SOLUBLE ORGANIC COMBINATIONS FROM HARD COAL AND THE LIKE. Friedrich Bergius and John Billwiller, Hanover, Germany.

1. The process of treating products of carbonization of vegetable matter which consists in subjecting them to the action of hydrogen at

elevated temperature of less than 600 degrees centigrade and at high pressure of more than 20 atmospheres until liquid or low-melting-point reaction products of the solid carbonaceous matters are formed.

1,252,103. PAINTING APPARATUS. James S. Gilmer, Knoxville, Tenn.

1,252,178. EVACUATION AND COMPRESSION OF GASES. Edmund Scott Gustave Rees, Stafford, England.

1,252,211. SANDING DEVICE FOR LOCOMOTIVES. William H. White, Roanoke, Va.

1,252,254. METHOD OF AND APPARATUS FOR INJECTING FUEL INTO COMBUSTION-CHAMBERS. Joseph O. Fisher, U. S. Navy.

1,252,614. HOT-AIR SYRINGE. Oscar H. Pieper and Alphonse F. Pieper, Rochester, N. Y.

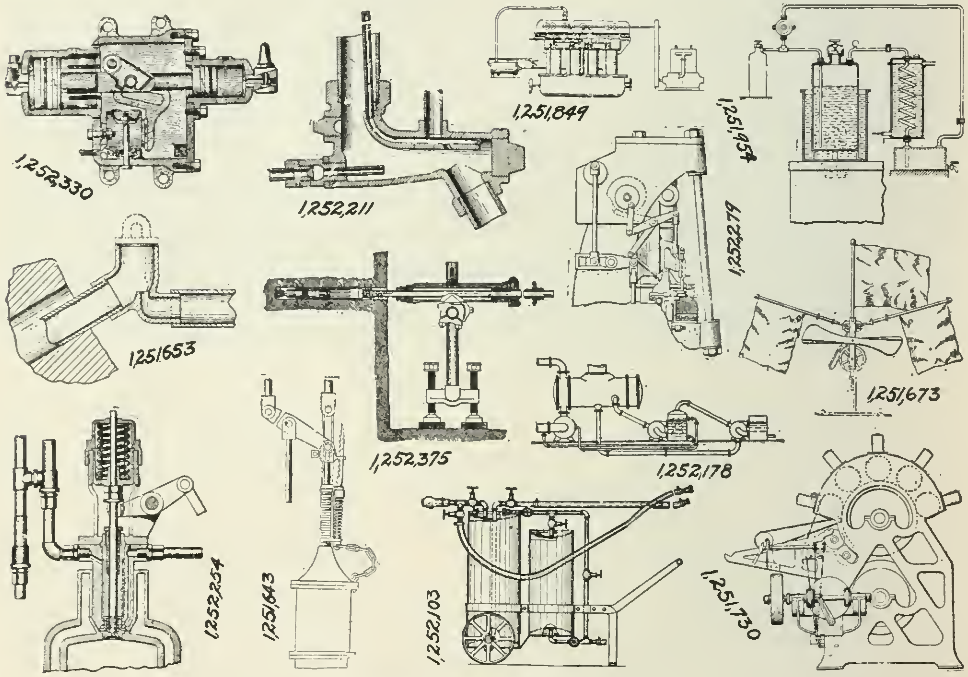
1,252,623. PRESSURE-REGULATOR FOR A FLOW OF FLUID. Charles H. Smoot, New York, N. Y.

1,252,780. DIVER'S HELMET. Ferdinand Ludwig Claren and Hermann Stelzner, Lubeck, Germany.

1,252,799. FLUID-PRESSURE MOTOR AND TRANSMISSION APPARATUS. Edward E. Gray, Plano, Ill.

1,252,904. FLYING-MACHINE. Andrew M. Hirmer, Millvale, Pa.

1,252,905. VACCUM STREET-CLEANING MACHINE. Eddie E. Johnson, Toledo, Ohio.



Pneumatic Patents January 1.

1,252,279. WORK-SEPARATING MEANS. Charles D. McDonald, Chicago, Ill.

1,252,280. SUCTION-CUP. Charles D. McDonald, Chicago, Ill.

1,252,330. AUTOMATIC TRAIN-STOP. Adiel Yeaman Dodge, Chicago, Ill.

1,252,374-5. DRILLING-MACHINE. George H. Gilman, Claremont, N. H.

JANUARY 8

1,252,487-8. METHOD FOR ASCERTAINING THE LOCATION OF LEAKS IN UNDERGROUND FLUID-PRESSURE PIPES. George V. Payne, Chicago, Ill.

1,252,490. HYDRAULIC, STEAM, OR AIR VALVE. Nicholas U. Peris, Steelton, Pa.

1,252,508. VENTILATING-FAN. John Stanley Glasspoole Telfer and James Henry Cartner Boyd, London, England.

1,252,557. PROCESS AND APPARATUS FOR INCREASING THE PRODUCTION OF OIL-WELLS. Irwin L. Dunn, Marietta, Ohio.

1. A process of operating oil wells which consists in introducing compressed gas to the oil sand in which the wells are located, maintaining a column of oil in the well to be pumped to exert a back pressure upon the compressed gas, and pumping the oil from said wells.

1,253,026. CENTRIFUGAL REFRIGERATING-MACHINE. Victor J. Goetz, Philadelphia, Pa.

1. A centrifugal refrigerating machine, having intercommunicating high and low pressure chambers to receive the refrigerating and the compressing mediums, and an aspirator operated by centrifugal force on the compressing medium to continuously aspirate the gaseous portion of the refrigerating medium from the low pressure chamber to the high pressure chamber and change it to a liquid.

1,253,030. PNEUMATIC ACTION FOR PLAYER-PIANOS AND THE LIKE. Adolph P. Gustafson, Chicago, Ill.

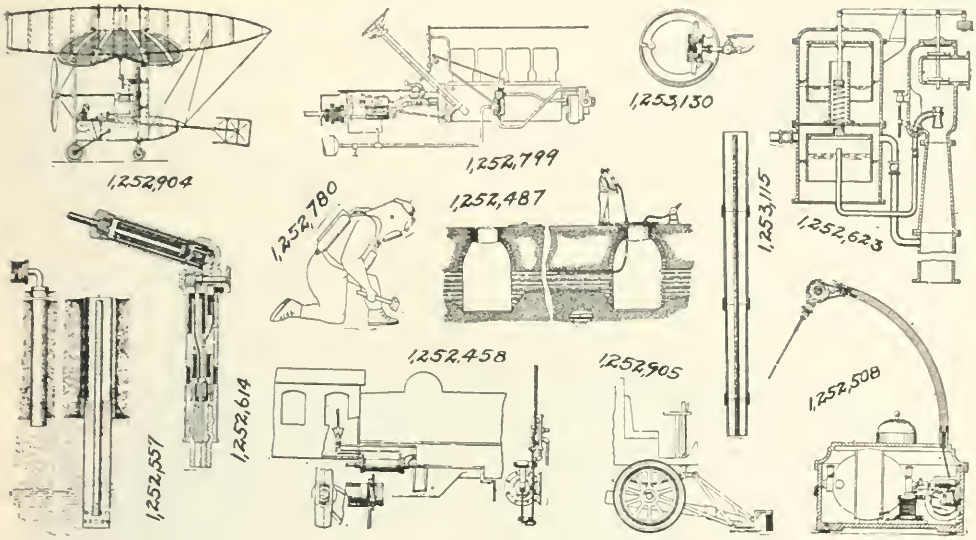
1,253,115. AIR LIFT-PUMP. Charles W. Whitney, Chicago, Ill.

1. An air lift or pump eduction piping composed of a series of cast iron sections coupled together so as to provide a smooth interior, the external diameter of a section being substantially identical throughout its length while the internal diameter is gradually and constantly increased from one end to the other.

1,253,130. AIR-BRAKE MECHANISM. Edward S. Bock, Ellinwood, Kans.

JANUARY 15

1,253,233. ABDOMINAL - MASSAGE IMPLEMENT. William C. J. Guilford, Harrison, Me.



PNEUMATIC PATENTS JANUARY 8

1,253,266. AIR-INLET DEVICE. William Melton, Jr., Neola, Iowa.

1,253,290. ROCK-DRILL. William A. Smith, Denver, Colo.

1,253,291. DRILL-SHARPENER. William A. Smith, Denver, Colo.

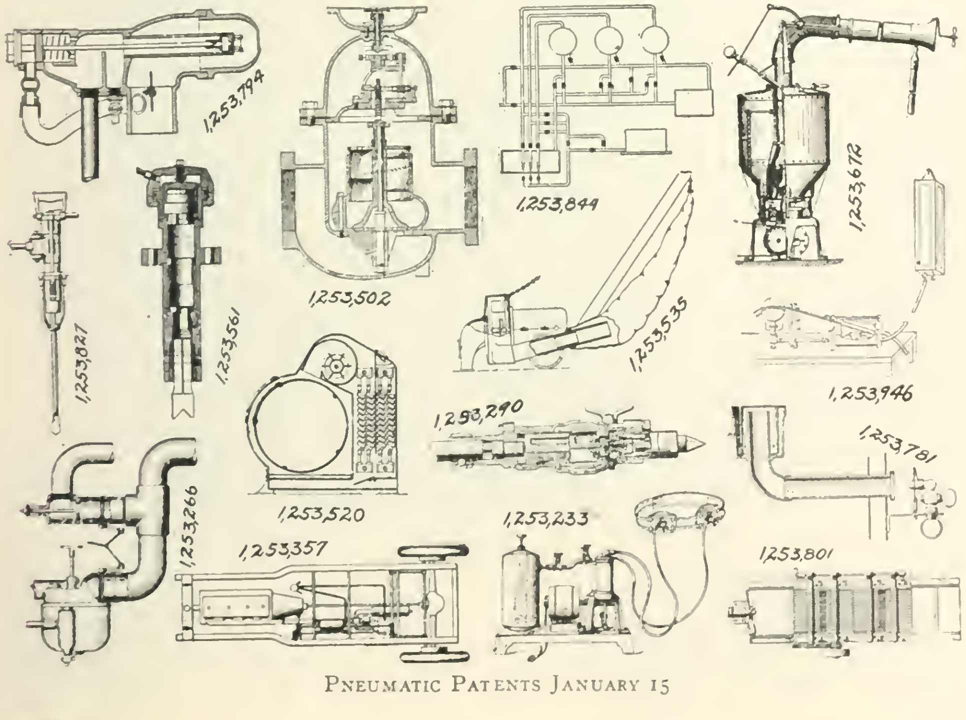
1,253,357. FLUID - PRESSURE - OPERATED APPARATUS FOR STOPPING AUTOMOBILES OR THE LIKE. Eli M. De Lay, Chattanooga, Tenn.

1,253,401. APPARATUS FOR TREATING AIR WITH LIQUIDS. John H. Lorimer, Philadelphia, Pa.

1,253,502. CURRENT FLUID-METER. Frank Lambert, Brooklyn, N. Y.

1,253,520. DRYING-TUMBLER. John H. Ostertag, Columbia, Pa.

1,253,535. SUCTION-CLEANER. William W. Rosenfield, New York, N. Y.



PNEUMATIC PATENTS JANUARY 15

1,253,558-9. PUMP AND PUMPING SYSTEM. Burton S. Aikman, Milwaukee, Wis

1,253,561. POWER-ACTUATED IMPLEMENT. Oliver O. App, New York, N. Y.

1,253,650. AIR-COOLED TOOL. Louis J. Van Guelpen, Cincinnati, Ohio.

1,253,672. DUSTING AND SPRAYING APPARATUS. Frederick J. Decker, Rochester, N. Y.

1,253,781. BURNER FOR NATURAL GAS. Zenas H. Brown, Cleveland, Ohio.

1,253,794. AUTOMATIC OIL-BURNER. Albert B. Deem, Indianapolis, Ind.

1,253,827. PNEUMATIC TOOL. Charles A. Hultquist, Los Angeles, Cal.

1,253,844. PROCESS AND APPARATUS FOR IMPREGNATING WOOD AND OTHER POROUS MATERIALS WITH PRESERVATIVE LIQUID. Henry S. Loud, New York, N. Y.

2. The method of impregnating wood with a liquid preservative under atmospheric, superatmospheric, and hydraulic pressures, successively, which consists in subjecting the articles to such treatment in a three-fold cycle, the coincident operations in the several cycles being different, the completion of the operation in each cycle initiating, and carrying through, a like operation in the succeeding cycle.

1,253,856. TIRE-INFLATER. Melvon A. Marquette, San Francisco, Cal.

1,253,859. AIR - CUSHION SWEAT-BAND. Harry Mertz, Baltimore, Md.

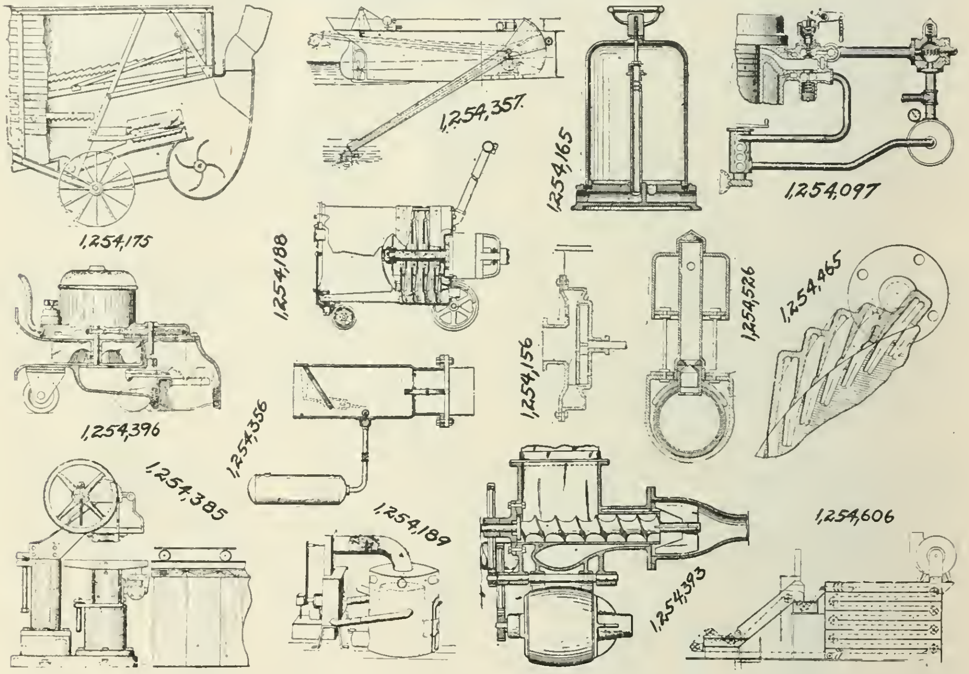
1,253,946. DENTAL - BLOWPIPE BURNER. Jose Antonio De Carvalho, Jr., Rio de Janeiro, Brazil.

1,253,976. DOUBLE - ACTING AIR-PUMP. Robert D. Hughes, Lynchburg, Va.

JANUARY 22

1,254,097. INTERNAL - COMBUSTION ENGINE. Carl W. Weiss, Brooklyn, N. Y.

1,254,156. FLUID PUMP, TURBINE, AND THE LIKE. Richard C. Parsons, London, England.



Pneumatic Patents January 22.

1,254,165. VACCUM-TANK. Karl D. Smith, Battle Creek, Mich.

1,254,175. FEEDER FOR PNEUMATIC STACKERS. Gilbert Thompson, Burns, Mont.

1,254,188. PUMP FOR PNEUMATIC CLEANERS. George W. Allen, Boston, Mass.

1,254,189. AIR-MOISTENING DEVICE. Frederic F. Bahnson, Winston-Salem, N. C.

1,254,356. NEBULIZER AND VAPORIZER FOR INTERNAL-COMBUSTION ENGINES. Henry M. Reichenbach, Detroit, Mich.

1,254,357. SUCTION-DREDGE. John Reid, New York, N. Y.

1,254,385. JAR MOLDING-MACHINE. John T. Anderson, Davenport, Iowa.

1,254,393. PULVERIZED - FUEL AND AIR FEEDER AND MIXER. George W. Clendon, New York, N. Y.

1,254,396. VACUUM-CLEANER. Clifford C. Dance, Denver, Colo.

1,254,465. ELASTIC-FLUID TURBINE. Oliver D. H. Bentley, Boston, Mass.

1,254,520. COMBINED LIGHT AND AIR TRANSMITTING APPARATUS. Daniel M. Macduff, Detroit, Mich.

1. In an apparatus as specified, the combination of a plurality of connected tubes, means for conducting the sun's rays in pencils through said tubes, means for producing artificial illumination in said tubes, an air vent in said tubes through which the air may circulate, the pencils of light from the sun's rays and from said artificial light being adapted to heat the air and accelerate the circulation thereof.

1,254,526. AUTOMATIC TIRE-PUMP. Michael D. Murray, Ambridge, Pa.

1,254,606. EVAPORATOR. Ralph W. King and Herbert G. Miller, The Dalles, Oreg.

1,254,612. APPARATUS FOR PURIFYING AND HUMIDIFYING AIR. Adolph W. Lissauer, New York, N. Y.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

Vol. xxiii APRIL, 1918 No. 4

FINE CONTROL OF AIR CHARGE

COMPRESSED AIR IN THE WAR

From the very beginning of the war compressed air was sure of a job at the front, and as long as the strife continues it will be doing its bit. Its employment is not contingent upon emergencies that may arise but is a part of the everyday routine of army operations. As modern war equipment is so largely mechanical there is a large demand for the entire line of pneumatic tools and they are

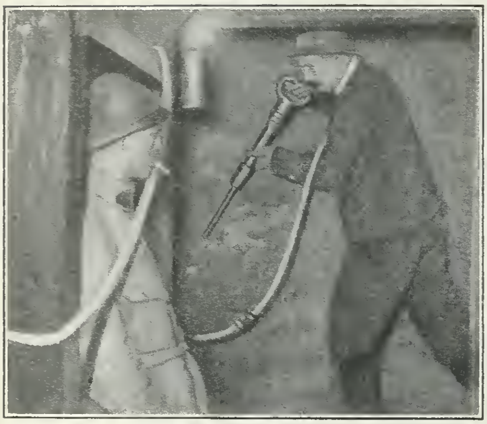


FIG. 1

purchased and put into service by the thousand, with ample compressor capacity, in small units, for driving them. Many of these little compressors are mounted upon motor trucks which can go anywhere, and those of a somewhat larger type, mostly electric driven, are always near the trenches.

For trenching is practically all mining work involving much rock cutting and tunnel driving which must be done with a rush. Of the photos which come to us from the war, many of them most satisfying and realistic views of what is actually going on, it is much to be regretted that, as one of the imperative condition of their transmission, no story comes with them. For instance, Figs. 1 and 2, here reproduced from the *Scientific American*, Feb. 23, show us two bona fide war scenes from "somwhere in France," and they might as well be "somewhere in Montana" so far as they tell us anything. Fig. 1 will be recognized as a Crown Coal Pick, and Fig. 2 as a Jackhamer, both giving good account of themselves wherever they are.

Another most interesting and now most effective and responsible use of compressed air is for the mortars which drop grenades into the trenches. For this service the air proves to be much better adapted than any type of explosive, not only for its noiselessness but also for the precise adjustment and control of its action. Although the range of these air mortars is short, precision is required for their delivery as much as for the long range guns. The point at which the projectile is dropped and the angle at which it is delivered are determined not only by the angle of elevation of the piece but also by the pressure and volume of the charge of air, and these particulars can now be finely adjusted to the requirements and varied as may be with each discharge.

In Fig. 3 is seen an air mortar on trial. A double result is in fact being secured. Not only are all the particulars concerning the action and delivery of the piece being ascertained but also the judgment of the men who are to manipulate it is being developed. To those who stand in rear of the piece the entire flight of the projectile is perfectly visible.

These compressed air mortars have been rapidly improved under the suggestions of experience and one of the latest is seen in Fig. 4. At the left is seen a portable tank which may be charged with air perhaps up to a pressure of 2,000 pounds, enough for several shots. The pressure required for a single discharge may be not more than 100 pounds, varying with the distance or angle of delivery. At the side of the main gun barrel is an auxiliary chamber to hold the individual charge of air. At the top of the pressure tank, near the hand of the operator, are seen two little pressure gages, one showing the pressure in tank and the other the pressure in the auxiliary chamber. A valve is opened and air is admitted from the pressure tank into the auxiliary chamber, and when the pressure required for the charge is reached the valve is closed and all is ready for the shot. The actual firing is done by the tripping of a quick acting, wide opening valve between the auxiliary chamber and the main barrel. The loading and discharging may be very rapid

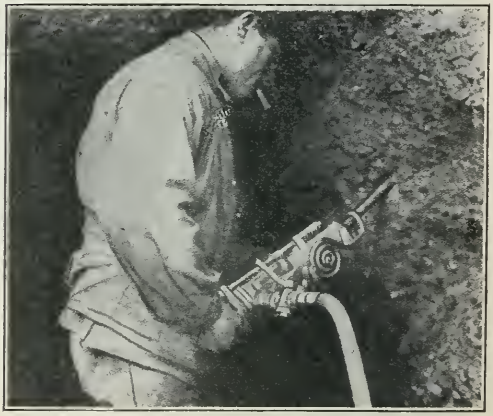


FIG 2

MEN LEARNING THE GUN

as long as the supply of air is kept up. There is of course no heating and no erosion to quickly destroy the piece.

NEW YORK CITY THE GREATEST SCHOOL FOR MINING ENGINEERS

An unusually satisfactory bit of work, even from him, was the address of Dr. Rossiter W. Raymond when the American Society of Civil Engineers was formally welcomed to its new home in the Engineering Building. The following is a little taste of it:

The mining engineer is simply an engineer engaged in mining, or connected with some of the arts that are associated with mining. The mining engineer is a civil engineer, plus a mechanical engineer, plus an electrical engineer. He has all the problems that torment those engineers, together with a torturing lot of his own that they don't have.

It is very pleasant to us to have this fact so thoroughly acknowledged as it has been in these latter years. The City of New York, as perhaps you have been told before, has been for the last few years the greatest mining camp on earth. During that period, with its immense system of subways and with its new water-supply from the Catskills and with its deep cellars under its lofty skyscrapers, New York has literally and not figuratively employed more miners and trained more mining engineers than any other mining field on this green globe—and we have made good mining engineers out of civil enginers. I can tell you that there is no such good raw material for a mining engineer as a real, thorough civil enginer. The great engineers that have designed, constructed and conducted the immense public improvements in this municipality within the past 20 years have not only taken up and acquired the art of mining engineering, but they have adorned it with new methods and with new achievements, before which we regular, trained, born mining engineers take off our hats.

At least that is the opinion of the late Professor Christy, dean of the greatest mining school in the country, I think not even second in numbers to our own great school at Columbia. Christy, after making a pilgrimage around the world, stopping at New York on his way, found more new and novel methods of mining in New York City, in our subways and under our pavements, than he had found elsewhere on the whole globe; and he wrote to me that such civil-mining engineers as Barclay Parsons were teachings us a new science of mining engineering. He had been underground where the rock was so rotten that it could not be either held up or bored through, and he found that they were squirting cement into the interstices of this rotten, old gneiss and making an artificial stone of it, much superior to the kind the Almighty had made—that is to say, after nature had had its way in weathering it for a few thousand aeons. They had consolidated this rotten mass until it was made into a splendid new mass of rock, and in that rock had made our subway tunnel with safety.

Not only to pierce the crust of the earth, but to create it in order to pierce it, is a double art, for which we mining enginers here and now desire to thank the society of civil engineers for having invented a new thing in our line.

AIR RECEIVER EXPLOSIONS

By Letson Balliet

The explosion of receivers in compressed air lines and the conduits for compressed air has caused considerable comment in the newspapers. Invariably the non-technical publishers attribute the cause of these explosions to the failure of the safety valve.

While the safety valve is an excellent thing to have upon an air receiver, in case of overpressure and particularly for the moral effect that it has upon the workmen in the vicinity of it, it is well to known that if the air receiver was equipped with a hundred safety valves, all in working order, they would not prevent the explosion if the conditions inside the receiver were right; in fact, the conditions inside the air receiver cause the same result that 50 lb. of dynamite would cause in the same receiver. It must be borne in mind that air receiver explosions are seldom, if ever, caused by excessive pneumatic pressure, but, on the other hand, they are really the explosions of highly combustible oil-gases and vapors pumped into the receiver from the compressor. It is almost impossible to supply lubrication to a compressor in sufficiently small amounts that some oil-gases will not be carried into the receiver and conduits.

Air compressing is the reverse operation of the steam engine. With steam, the pressure is built up in an enclosed boiler, conducted into the cylinders of an engine where it expands, giving off power or energy, and is then exhausted into the atmosphere. The lubricators of a steam engine can safely use almost any amount of oil because it is exhausted into the open air. The air compressor receives its air at atmospheric pressure; power is applied to the pistons for the purpose of compressing it, to be exhausted into an enclosed receiver. Every bit of lubrication fed into the cylinders of an air compressor must eventually pass into the receiver.

It is well to call attention to the fact that the cylinders of an air compressor are not subject to the scouring action that the steam cylinders of an engine are, hence it needs less lubrication in the first place.

Frequently engineers adjust the lubricators for the steam-end and the air-end of the compressor alike, and sometimes when automatic governors control the speed of the compressor the lubricators feed the same amount of oil per minute at slow speed that they feed at high speed.

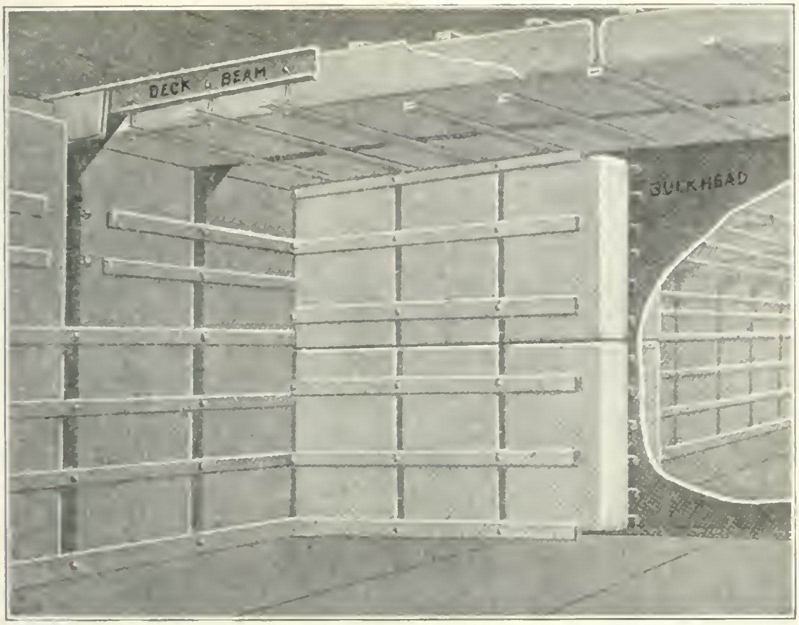
There is, or should be, always an attempt to use lubricating oils that are low in carbon, but no matter what method of lubrication is used it may always be put down as a fact that more or less oil-gas and oil-vapor from lubricating oils is pumped into the air receiver. This is combined with more or less dust gathered from the air, some of which settles in a thick viscous scum upon the inside of the receiver shell, while some of it passes off in gas through the conduits and tools. In fact, I have known men in poorly ventilated mines to be overcome from oil gases that come from the exhaust of rock drills.

The passing of a carbon spark, that may have become ignited with the heat of compression or friction, into the air-receiver might, and probably does, cause the ignition of the oil gas within the receiver, which results in a violent explosion.

Another point which I wish to make in this article is that all lubricating oils used in compressors are marked with a supposed flashing test to indicate the temperature at which the oil will flash, but these tests have all been made at atmospheric pressure, a condition which does not exist in the inside of an air-receiver, nor does the test indicate at what temperature the flash will occur when the lubricating oil has been broken down into a gas.

In line with this thought, I wish to call your attention to the fact that a candle taken down into a caisson, where the operations are conducted under two or three atmospheres, will burn with a much more brilliant flame than the same candle will burn at atmospheric pressure; in other words, the combustion is much more rapid under pressure than at atmospheric pressure, and conversely, a candle taken up to the top of a high mountain will burn with a very sickly, weak flame. This point in combustion is one of the examples cited in our elementary physics, and yet it seems to have been ignored in the study of air receiver explosions due to lubricating oils. Therefore, I am satisfied to say the combustion of lubricating oil and oil-gas must be more violent and rapid under pressure of eight or more atmospheres than at atmospheric pressure, and I am forced to believe that the so-called flash point of liquid lubricating oil at atmospheric pressure is of little value because it does not give the point at which the oil-gas will flash under pressure.

My deductions from the foregoing studies are that the air receiver should be supplied with a manhead and that it should be opened and thoroughly cleaned of the oil and dust that accumulate on the inside of the shell; that it should be frequently drained, and the lubrication of the compressor reduced to the minimum, and it is probably needless to add that the best grades of oil should always be used in the compressor cylinder.—*Power Plant Engineering.*



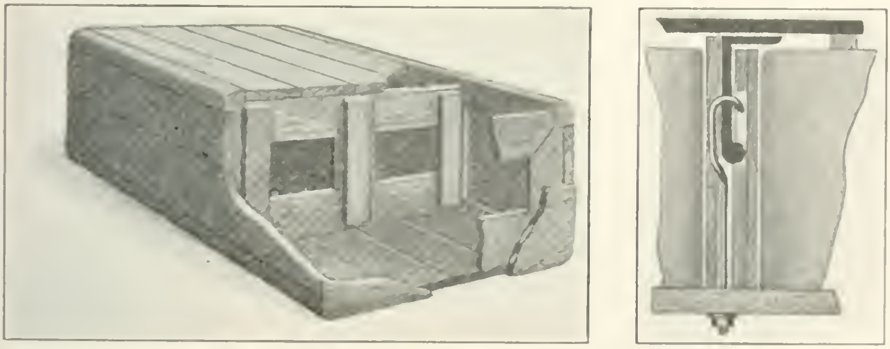
VIEW IN HOLD WITH BUOYANCY BOXES PLACED

MAKING THE SHIP UNSINKABLE

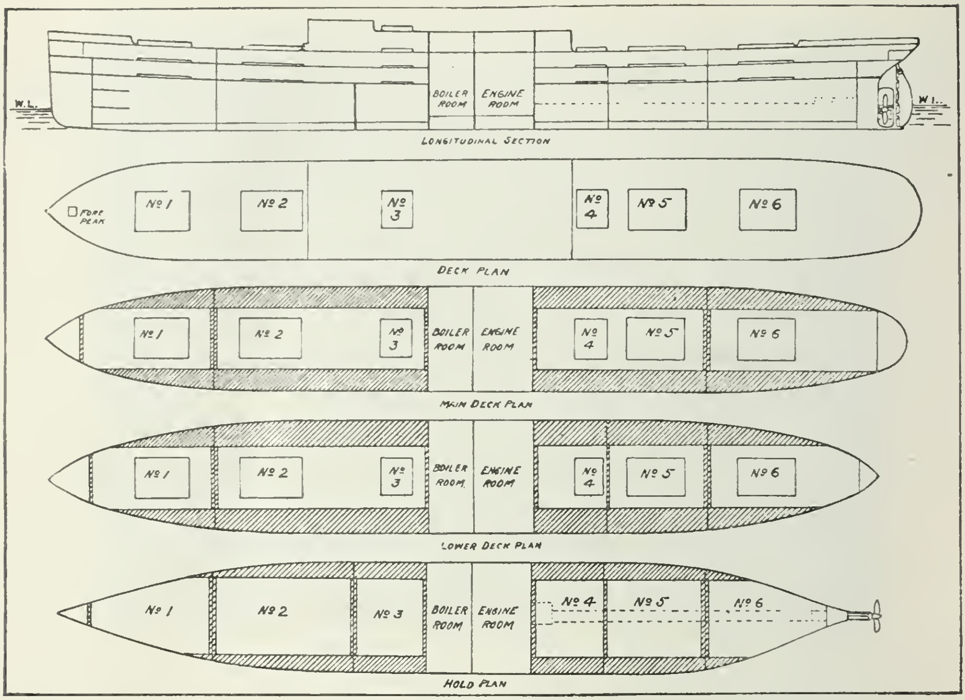
The first officially recognized attempt to render a freightship so far unsinkable that she can take the blow of a torpedo without going to the bottom, is about to be put to a practical test by sending the "Lucia," formerly an Austrian vessel, through the submarine zone. Before very long, this ship will start for Europe with her sides, bulkheads, and the under sides of her decks padded with several thousand wooden water-tight boxes, upon whose buoyancy dependence will be placed for keeping her afloat, even if she should sustain injuries which would inevitably send her to the bottom under normal conditions.

The plans for rendering the "Lucia" unsinkable were worked out by Mr. William T. Donnelly, with the approval of the Naval Consulting Board, and great expectations are entertained as to the success of the venture.

It should be understood, of course, that this scheme of protection is to be regarded as emergency work done on ships afloat—that is to say, it is not proposed to construct new ships along standard lines and then load them with wooden boxes in this fashion. In view



DETAILS OF BOX CONSTRUCTION AND MODE OF FASTENING



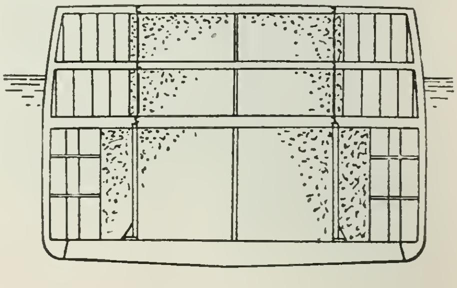
DECK PLANS

of the great lack of tonnage and the urgency for getting our men and their supplies, to say nothing of food for the Allies, across to Europe, any plan which will conserve our shipping and cut down the loss without an undue expenditure of time and money, is entitled to a fair trial. Such, at least, we judge to be the attitude of the Naval Consulting Board in sanctioning this very ambitious experiment.

The "Lucia," which is 432 feet long by 49 feet broad and 38 feet deep, has a maximum deadload capacity of 10,000 tons on her maximum summer draft and of 9,400 tons at her maximum winter draft.

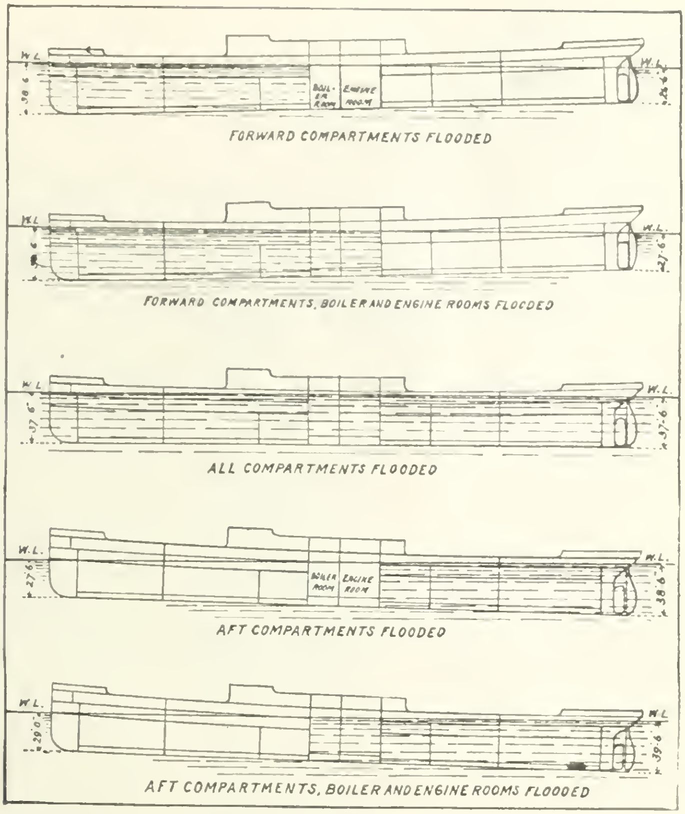
As will be seen from the accompanying line drawings, the ship has six watertight bulkheads, which divide her into five cargo holds, a boiler and engine room compartment, and a collision compartment at the bow. She has three decks, and the system of flotation boxes is applied throughout the full length of the cargo spaces on all three decks. The plans show the ship as arranged for carrying a cargo of coal. The shaded portions in the deck plans represent the extent to which the hull under these conditions, will be filled up with the flotation units. In her normal condition, the "Lucia" can carry 10,000 tons of coal but with the boxes installed she carries 8,300 tons. The total hold capacity of the ship is 508,000 cubic feet when she is provided with a sufficient number of flotation units to protect her against sinking. Of this 152,000 cubic feet will be taken up by the flotation units, and the balance of 356,000 cubic feet at 43 cubic feet per ton will be occupied by the load of 8,300 tons of coal.

The flotation units are made in three sizes—the smallest is 12 inches deep by 25 inches wide and 3 feet, 1¾ inches long; the next is 18 inches deep by 27 inches wide and 5 feet, 9 inches long; the third, and largest, is 30 inches deep by 30 inches wide by 6 feet, 2



MIDSHIP SECTION

inches long. All the boxes are made of ⅞-inch North Carolina pine, and the details of construction are shown clearly in the accompanying sectional perspective view. Two interior transverse bulkheads are provided in each box, and all boxes are covered with galvanized metal to render them watertight. The various units are constructed to withstand pressures corresponding to 10, 20 and 30 feet of water, according to their location in the ship. The method of stowing the boxes is shown in a perspective view of one of the decks. It will be noticed that they are stowed in between the frames of the hull and between the deck beams on the under side of the decks. The boxes are held in their respective positions by means of battens and threaded bolts, the latter being hooked into the frames and deck beams, and the whole system being brought up snugly into position by means of washers and nuts on the outside of the battens.



TORPEDOED SHIP IN VARIOUS CONDITIONS

To render a ship unsinkable, three separate conditions are to be considered. First, when she is unloaded; second, when she is loaded with a mixed cargo, and third when she is loaded with a dense, heavy cargo, such as a cargo of coal. For the first condition, reserve buoyancy sufficient to make the ship unsinkable when she is unloaded, is attained by fitting a single layer of flotation units between the frames and deck beams and against the watertight tranverse bulkheads. Cargo reserve buoyancy is determined by the nature of the cargo itself and the cubical area occupied. For instance, in the case of a 5,000-ton ship, 56 cubic feet is allowed per ton, making a total for that ship of about 280,000 cubic feet. The reserve buoyancy units necessary to float the ship when it is unloaded equals about ten per cent. of this tonnage, or 500 tons, leaving a net tonnage of 4,500 tons or 252,000 cubic feet. A coal cargo requires 43 cubic feet of space per ton, which on the net tonnage of 4,500 tons amounts to 193,500 cubic feet. This is deducted from the total net cubic feet and leaves reserve space of 58,500 cubic feet for reserve buoyancy units to float the deadweight cargo. It is claimed by the sponsor for this system that the loss of cargo space in a ship that is self-salvaging is more than offset by the salvaging of the cargo and of the ship itself.

Should this method of protection prove to be successful, it will provide a powerful incentive for the construction in all ships of permanent self-salvaging qualities — something which is sadly lacking in the average merchantship construction of the present day. —*Scientific American.*

GIBBS OXYGEN RESCUE APPARATUS*

It is a complete self-contained unit carried wholly on the back of the user. It is light and its parts are well protected against injury. A special device feeds the oxygen used, and although plenty is available for the wearer when working hard none is wasted when he is resting. Hence the new apparatus may be worn for a considerably longer time without recharging than can models now in use which furnish a constant volume. An unusually efficient carbon-dioxide absorber that liberates little heat is another feature of the apparatus. Caustic soda, which is much cheaper than the potash salt formerly thought necessary, is used as the absorbent.

GENERAL INFORMATION

Normal air contains roughly 20% oxygen mixed with about 80% nitrogen and a trace of carbon dioxide. At each inspiration part of the oxygen breathed combines in the lungs with carbon brought by the blood, and the air expired contains about 4% carbon dioxide. The nitrogen of the air is unchanged by the act of respiration and takes no active part in it other than to dilute the oxygen. The amount of oxygen consumed in the body is precisely the same whether the gas is breathed pure or diluted with nitrogen in the form of air. Contrary to the belief held a few years ago, there is no flushing of the face, no feeling of exhilaration, no increase in the pulse rate, nor elevation of arterial tension.

If, however, the oxygen content of the air breathed be materially reduced, unconsciousness and death are almost sure to follow without any warning symptoms, provided the carbon dioxide content of the air remains low. For this reason it is advisable that breathing apparatus supply an atmosphere rich in oxygen. As much of the oxygen made from liquid air contains 2 or 3% nitrogen, which remains unchanged and accumulates in the apparatus, analyses of the atmosphere breathed by the wearer generally show a decreasing content proportionate to the length of time the apparatus is worn. If the proportion of carbon dioxide in the artificial atmosphere rises much above 2%, deeper breathing or panting warns the wearer of danger, generally in time to let him get to safety.

DESCRIPTION OF GIBBS APPARATUS

The elements that enter into the construction of the Gibbs breathing apparatus are shown in the diagram, Fig. 1. When the wearer inhales through the mouthpiece *A*, the valve *B* opens and oxygen passes from the bag *C* through the cooler *D* to the lungs. On exhalation the oxygen, somewhat diminished in volume and containing about 4% carbon dioxide, issues from the mouth. The valve *B* now closes, but the valve *E* opens to let the mixture of oxygen and carbon dioxide pass into the absorber *F*, where the caustic soda combines with the carbon dioxide to form sodium carbonate with the formation of some water and the liberation of heat.

From the absorber or regenerator the purified oxygen passes by way of the duct *G* to the breathing bag *D*, which expands to make room for it. The total volume of gas in the apparatus is now less than the original volume by the amount of carbon dioxide taken up by the absorbing can. After the wearer of the ap-

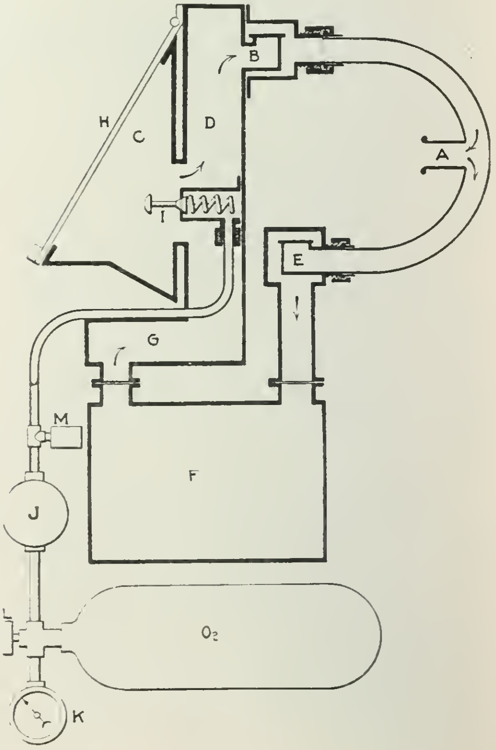


FIG. I

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*This apparatus, in several respects superior to other types, has been developed by Mr. W. E. Gibbs, engineer of mine-safety investigations, in cooperation with other members of the staff of the U S. Bureau of Mines.

paratus has taken a few breaths, the bag *C* collapses enough to permit the weighted lever *H* to open the oxygen-admission valve *I*, when the bag *C* fills again automatically. The heat generated in the absorber is removed from the gas by radiation, partly from the cooler *D* and partly from the bag *C* and the connecting tubes. A reducing valve *J* lowers the pressure of the oxygen from about 2000 lb. per sq. in. in the bottle to a pressure that may be controlled by the admission valve *I*. A pressure gage *K* indicates the available oxygen. The gas may be turned off by the stop valve *L* when the apparatus is not in use. A relief valve *M* operates when the pressure in the circulatory system becomes too high. In order to be practicable, breathing apparatus should be mounted on a suitable frame and be conveniently supported on the user.

A magnalium casing contains the valve-closing toggles, which are actuated by a flexible metallic bellows. Except for a rubber gasket at the junction of the casing and the toggles, all the parts are of metal. When this reducing valve is attached to a cylinder of gas at a pressure of 150 atmospheres, the pressure inside the bellows, with the outlet closed, is about one-sixth of an atmosphere. This remains constant even after the outlet has been shut several hours. Such a reducing valve makes it possible to admit oxygen intermittently to the breathing bag in the exact quantity required by the user under conditions varying from complete rest to extreme labor. All parts of the breathing apparatus are mounted on a frame of steel tubing which is carried on the back. The illustration shows the apparatus in use with its protecting cover of aluminum removed.

The absorbing can *F* has been the subject of much experiment. A form tentatively adopted contained 20 vertical sheets of fine iron-wire gauze, held parallel to each other and one-fifth of an inch apart by spacers. These sheets before being put in the can were dipped in molten caustic soda containing 20% water. The caustic solidfied on the gauze when cold, forming reinforced plates about 1-16 in. thick, between which the expired air passed. The plates not only absorb carbon dioxide from the wearer's breath but maintain a uniform surface from which the condensed and chemically produced moisture drains away, so that the capacity of the absorber is nearly constant until the active material has all been used. Recently another type of absorber, containing caustic soda in lumps, has been adopted.

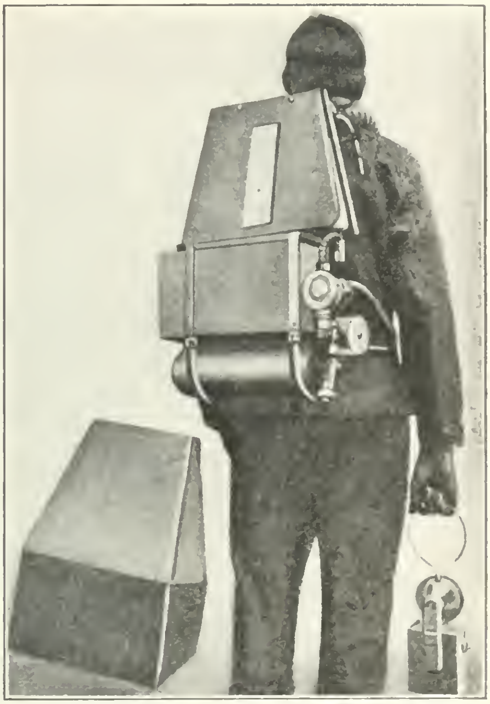


FIG. 2

A pressure gage or "finimeter," which is read by touch, instead of sight, and sounds an alarm when the oxygen in the cylinder has been reduced to 30 atmospheres, completes the apparatus. The whole device, which weighs only 30 lb., or considerably less than other types, is suspended from the shoulders by leather straps. There is a minimum of parts. All the connections have been made without the use of rubber wherever possible. A simple mouthpiece and nose clip is used instead of a helmet. Experience has shown that the helmet is dangerous, and its use has been abandoned by the Bureau of Mines. The pressure within the apparatus is maintained slightly above that of the atmosphere by the pressure of a weighted flap *H* on the breathing bag. Consequently, if the apparatus is punctured, or if a crevice in any part of the system opens, the leakage is outward only. Exhaustive tests of the new apparatus have shown that it permits unusually free breathing; that the air supplied is comfortably cool; that as the front of the body of the wearer is entirely free he is not hampered in his movements; and that the parts of the device are well protected against accident.

COMPRESSED AIR FOR CLEANING MOTORS

By D. R. Shearer

In a great many manufacturing plants, especially those working in wood or a similar material, the driving motors have a tendency to become clogged with dust in a short time. Such accumulation of dust is a fire hazard, particularly if the motors are overloaded and liable to have coils burn out; and if a motor is not overloaded, it may heat if the air ducts are filled with dust. Moreover, the motor is not able to carry the peaks when called upon, for the reason that the additional heat cannot be dissipated. Motors should be cleaned frequently, but such cleaning with the means ordinarily at hand is a rather difficult procedure since the air ducts are usually small and difficult to clear with a brush. The windows may be brushed off externally, but such cleaning does not reach the real seat of the trouble.

One of the best methods is compressed air under considerable pressure. If the air is not available from some source already in use, it is advantageous to use a small motor-driven compressor and a storage tank. The compressor should have a capacity of from 4 to 10 cu. ft. of air per minute at a pressure of 100 lb. per sq. in., and the tank should hold from 40 to 100 cu. ft. This size will take care of the average plant.

In piping a factory the air line can be 1-in., ¾-in and ½-in. pipe. Since the amount of air used in cleaning any one motor is small, a large pipe is not necessary. An outlet with a valve should be placed near each motor, or if they are grouped, several motors can be reached from one outlet with ½- or ⅜-in. hose; the smaller size is more easily handled. The nozzles can be made up of brass rod of suitable sizes and shapes, one of which is shown in the illustration. It is necessary, however, to use nozzles with small openings as a large nozzle opening would consume too much air. Probably the most useful sizes would be 3-32, 1-16 and 3-64 inch, and these three nozzles will meet most conditions.

Sometimes it becomes desirable to clean surfaces with air; for instance, the walls or ceilings of the buildings. This may be done with a tool made from ⅜- or ½-in. pipe in which there are a number of holes, as shown, to form a "brush" of escaping air. For ordinary purposes holes of about 1-32 to 1-64 in. can be used.

These small nozzles do not clog readily if all the scale and dirt is blown out of the piping. As an investment such a cleaning system will be found to pay for itself in the reduction of motor troubles and the decrease in fire hazard.—*Power.*

SHARPENING AND DISTRIBUTING MINE DRILL STEEL

By Howison Crouch

The present system of distributing drill-steel at the Empire mine, Grass Valley, California, has been in use 20 months, and the results have been so favorable as to warrant a brief description. It was developed to overcome the weakness of the old method, which became apparent when the milling capacity was increased and greater tonnage demanded.

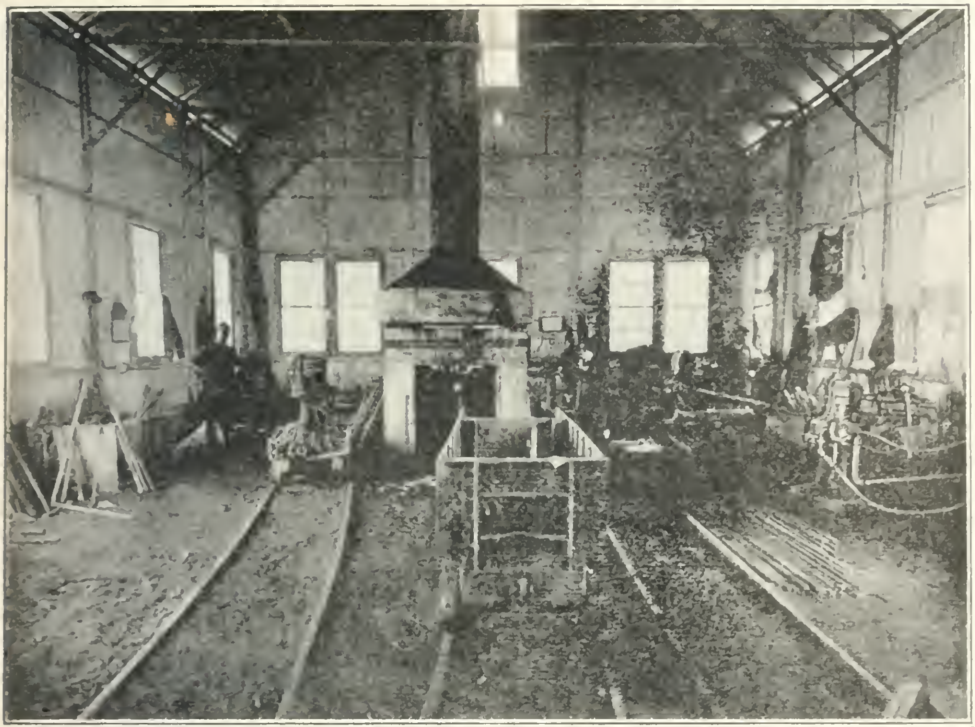
THE OLD SYSTEM.

Under the old system, sharp steel was sent down in the morning for the use of the day shift, and the steel that had been dulled on the previous night shift was brought up. Part of this dull steel would be sharpened and sent down again in the afternoon for the use of the night shift. In spite of this apparently active circulation, the miner was often kept waiting for steel. If he was not lacking in the number of drills he was likely to be short of the desired lengths.

THE NEW SYSTEM

Under the new system enough steel is provided for two full shifts in each stope. The sharp steel is delivered to each level but once a day, this being the last thing done before the night-shift men are hoisted, and is part of the duty of the skip-tender and helper.

The steel is handled on two trucks specially made for the purpose, with compartments for keeping the allotments for the various levels separate. The dull steel from the previous two shifts is on the stations and is picked up the same trip. Gates are provided at the collar of the incline shaft, and the trucks, loaded with dull steel, are run direct to the tool sharpener's shop, where it is sorted and counted. After sharpening and tempering, it is replaced on the truck according to a tag, which will be mentioned later, sent from underground by the tool-boy. Any shortage due to breakage, or any extras demanded, are provided from the



DRILL SHOP, EMPIRE MINE, GRASS VALLEY, CALIFORNIA

stock-pile, which is supposed to be kept adequate for all emergencies.

THE DRILL RECORDS

Each tool-boy is provided with a book, conveniently ruled and furnished with carbon, in which, as he visits a stope on any particular level, he records the number and the lengths of the dull drills taken out. After he has visited all the stopes on a level, he tears off a tag from his book, which is given to the mule-driver on that level, showing the number and lengths of sharp steel to be delivered from the supply at the stations to the steel-racks provided at the manways, leading to the stopes. The rest of the leaf of the tool-boy's book is sent to the shop, and shows the number and lengths of sharp steel to be put on the truck in the proper compartment for that level. The broken steel is also recorded and a similar piece substituted when the truck is loaded.

The theoretical result is that each stope is always provided with enough drills of the right kind. Each level and stope gets back on the next truck the same number and kind of sharp drills that were taken away dulled on the previous day, including the broken steel. The actual result approaches this condition quite closely, considering that four different sets of men handle the business; also due allowance must be made for carelessness and indifference. The six levels from 3000 to 5000 ft. inclusive are visited by two tool-boys, who collect and record the dull steel from the working-places. The ore-bodies are, in most cases, at a considerable distance from the shaft; consequently the steel must be transported on each level for distances varying from 1000 to 4000 ft., and must be collected from and distributed to three to twelve working-places.

SLIDES FOR THE STEELS

The pitch of the vein is about 40°, and, therefore, to facilitate the handling of the dull steel in the stopes, slides have been placed in the manways, through which the steel is delivered to the level below, proper precautions being taken, of course, to avoid accidents. A detailed count of all steel underground and in the shops is made once every three months. The total number of pieces has remained nearly constant, refuting the objection that if an abundance of steel were furnished, there would be a high percentage of loss. The number of the longer lengths decreases, due to breakages, while the number of short drills increases. The short lengths recorded as being rejected because too short for use, correspond closely to the number of pieces of new steel cut. The record of broken drills seems to show that, when there is a shortage of drills in a stope, the percentage of breakage increases.

THE DRILLS IN THE MINE

Hammer stopers, using solid steel and a cross-bit, are used in the stopes, while the driving is done with water-machines using hollow steel with a cross-bit. There is a considerable variation in the character of the ground drilled, both in the drifts and stopes. The foot and hanging walls, in the lower levels, are granodiorite, and in many cases the fissure is not wide enough to afford suitable working space, and the drilling must be done in one or the other wall. Sudden increases in the hardness of the ground, especially in the drift, sometimes causes a heavy demand for drills, but if the stock-pile has not been neglected, the emergency is readily met.

TOOL SHARPENING EQUIPMENT

The tool-shop equipment consists of two No. 5 and one No. 3 Ingersoll-Rand pneumatic sharpeners, and one pneumatic punch of the same make, for clearing the holes in the hollow steel. Concrete tanks, with screens near the bottom, are used for tempering. Crude oil is used for fuel in the furnace, which is of the ordinary type, enclosed with a substantial brick wall, having openings on three sides, and provided with a hood and large flue for carrying off the waste heat. The structure itself is built of steel, no wood whatever entering into its construction. Worn T-rails were used for the frame and rafters, to which the roof and sides of corrugated iron are riveted. The dimensions of the building are 45 by 30 ft. with eaves 15 ft. high, giving plenty of air-space, and producing the maximum of comfort for the men. The work of the shop is done by three operators and two helpers, working eight hours per day.

A daily record is kept of the work done, including new steel cut, and while the amount varies somewhat at different periods, on account of fluctuating demand for drills, it will be fairly well represented by the three months of June, July and August, 1917. During this period, in which there were 79 working days, a total of 51,029 pieces of steel were handled, or an average of 645.9 pieces per day. An itemized statement of costs follows:

COST PER PIECE

	Cents
Labor	2.56
Crude oil	0.24
Compressed air	0.24
Furnace repairs	0.03
Sharpener repairs	0.01
Miscellaneous	0.01
Total	3.09

—*Mining Press,* San Francisco.

AIR OPERATED FIRE DOORS FOR LOCOMOTIVES

The use of pneumatic fire doors bids fair to become universal on steam locomotives. On locomotives of the heavier types not equipped with mechanical stokers they are a real necessity. Several very successful devices have already been perfected, and among these the Franklin Automatic Fire Door to which attention is here directed.

The essential features comprise a door frame, door plates, operating cylinder and a pedal which controls the movements. On what is called the "Butterfly" arrangement, here shown, the door plates are mounted on hardened steel pivots and work together through heavy gear teeth, one of the plates, or half-doors, being connected to the operating piston by a link. The door is opened by a movement of the piston, the power being compressed air admitted to the cylinder on which the piston is enclosed. When the piston reaches the maximum travel the door is fully open. Baffle plates are fitted to the door plates, and protect the door plates from the intense heat of the firebox. They also serve to heat the air that passes through the openings in the door plates. This not only aids combustion, but helps to maintain a more uniform fire-box temperature.

In Fig. 1 the hand lever will be noticed which is used for operating the doors when there is no air pressure, this lever having no

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*Condensed from *Railway and Locomotive Engineering.*

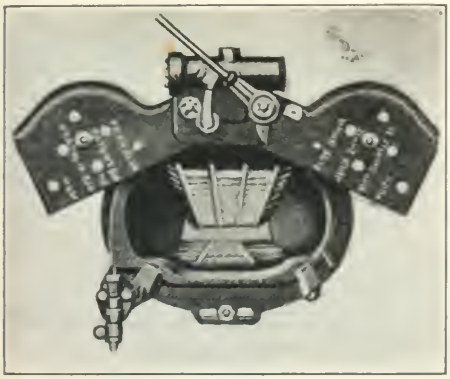

FIG. 1

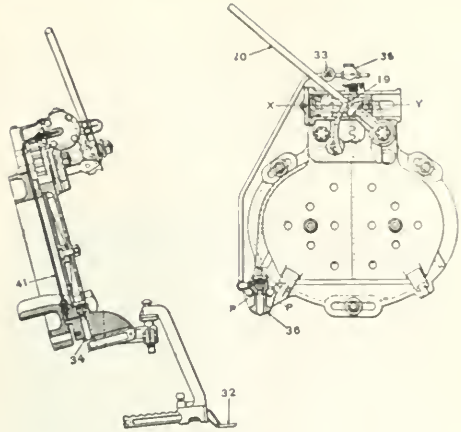

FIG. 2

motion when the air is used. In operation the air is admitted through a strainer valve and an adjustable valve into the operating valve. When the foot of the operator is placed on the tread a valve is opened at the lower part of the door, being raised from its seat, allowing the air pressure to pass through a pipe which connects the valve to the cylinder head. The enclosed piston is carried forward by the action of this air pressure, and transmits its movement to the doors through a link which is attached to the left hand door plate.

As the piston moves forward the door plates are rotated around the fulcrum pins until they have uncovered the opening in the door frame. In this position the link is centered, and it is impossible for the piston to travel any further. Should the momentum of the door plates be such as to carry the doors beyond the full opening position the piston would be pulled back against the air pressure in the cylinder. This would act as a cushion and bring the doors to a stop without jar or noise.

When the foot of the operator is removed from tread the valve closes, cutting off air pressure to the cylinder, at the same time permitting the air in the cylinder to exhaust to the atmosphere through an exhaust port in the valve body. The weight of the doors causes them to close, at the same time returning the piston to the left end of the cylinder. In closing the door is cushioned, and as the doors close rapidly there is sufficient pressure remaining in the cylinder, the exhaust being restricted, to slow up the movement of the doors and allow the plates to come together without slamming.

A latch having two notches to engage the hand lever is also provided. The first notch, which is known as the smoke notch, holds the door open about eight inches at the bottom to allow the admission of air to the fire-box, while the locomotive is standing at stations. The bottom notch is located so as to hold the doors in the full open position. The supply of air for operating the door should be taken from the main reservoir pressure.

In operation, the door should be opened and closed after each scoop of coal by means of the pedal, and from carefully collected data there is an average of 585 distinct movements on the part of the fireman for each ton of coal consumed on locomotives not equipped with pneumatic fire doors. This number of movements is reduced to an average of 234 by the use of the door described. On some long freight runs, where twenty tons of coal may be consumed, the relief to the fireman is very great.

The lessening of the labor of the fireman is not the only gain. The ready opening and closing of the door after each scoop excludes as much air as possible from the firebox, thus preventing the expansion and contraction of the tubes, keeping up the temperature of the firebox and insuring the air being drawn through the grates so as to furnish necessary air for combustion.

Extensive tests have also shown that in the amount of coal used on engines equipped and not equipped with the pneumatic fire doors the difference is considerable.

The care of the door involves little labor. An oil cup is provided on the top of the cylinder, and the fulcrum pins are oiled through oil holes on the front of the cylinder. All other parts of the door should be operated without oil.

The device is used in a variety of forms, some with the doors opening vertically, one portion moving upward and the other downward.

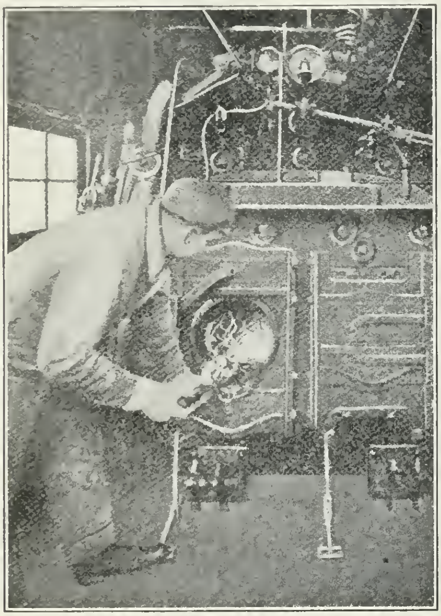

FIG. 3. VERTICAL SLIDING DOORS

DANGER OF OXYGEN RESCUE APPARATUS*

When oxygen rescue apparatus was first introduced in the United States and made use of in the mines following explosions and fires, there was a wide misconception on the part of many miners and mining men as to the extent to which it might be used, and the limitations of the physical endurance of those who volunteered to wear the apparatus. Many conceive the idea that with an oxygen apparatus a man immediately acquires superhuman strength and endurance. It is not putting it too strongly to state that a number of good men have gone to their death in an effort to satisfy a false belief on the part of spectators that the apparatus had no limitations, and that the wearer knew no limit of physical exertion.

The helmet type of apparatus has received condemnation by many scientific investigators, and the Bureau of Mines has publicly denounced its use for mine or fire-fighting purposes; still there are some who persist in its use, and they are but challenging death. Some helmets may be made to fit tightly temporarily, but the models now in use have large dead spaces, and under enforced breathing admit external air.

It is safe to say that a number of deaths here and in foreign countries have resulted through the wearer breathing his own carbon dioxide, or through leakage of external air into the circulating system of the apparatus. To overcome the re-breathing of air highly charged with carbon dioxide, an efficient absorber is one of the essentials; the apparatus, if of a constant-feed model, should supply an excess of oxygen above the requirements of the wearer; if an intermittent feed, there should be either a constant leakage externally or an auxiliary supply held within a flexible medium under small pressure, which will make the breathing circuit under positive pressure.

The difficulty experienced by designers and manufacturers heretofore has been that the physiological requirements have not been given full consideration. The apparatus has been constructed in a manner which enables the wearer to perform limited physical work. However, it is a source of gratification to report that some manufacturers are now enlarging the absorbers and providing a bypass valve and readjusting the zone of reduced, or negative, pressure.

The Gibbs apparatus, described in U. S. Bureau of Mines technical paper No. 82, is constructed with the sole idea of adapting the apparatus to the limitations of the wearer, whereas some types now in use require the man to adapt his activities to the limitations of the apparatus. This subject has been discussed in a technical paper issued by the Bureau of Mines under the Joint authorship of Dr. Yandall Henderson and James W. Paul, the subject of which deals with the status of oxygen-rescue apparatus and the physiological effect on users of such equipment.

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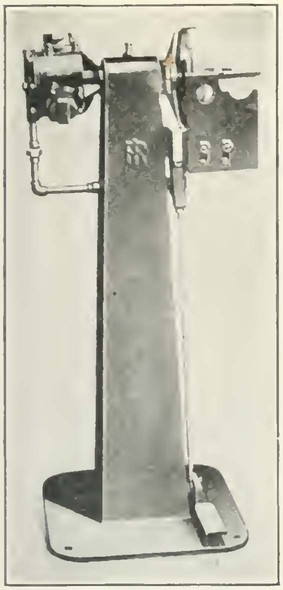
*Abstract of an article, "Status of Oxygen Rescue Apparatus and Physiological Effects on Users," by James W. Paul, chief of coal-mining investigations, U. S. Bureau of Mines, Pittsburgh, Penn.; presented at the meeting of the National Safety Council, New York, Sept. 13, 1917.



AN AIR DRIVEN PEDESTAL EMERY GRINDER

For general service in machine shops and elsewhere, where a stationary pneumatic grinder is more suitable than a portable tool the Ingersoll-Rand Company, 11 Broadway, New York City, is placing on the market the machine here shown, the No. 8 "Little David" grinder. The three cylinder motor, with its continuous power impulse, the rotary valve intyral with the crank shaft, and the triple ball bearing spindle are of design similar to the No. 7 grinder. The machine is rated to run at 3400 r.p.m with air at 80 lb. The foot lever provides complete control. The wheel normally employed is 8 in. diameter and 1 in. face.

PRECISE PAYMENTS FOR ACTUAL WORK DONE

Figures for 1917 covering the earnings of molders, molding machine operators, cleaners and other piecework employes, that are being compiled by foundrymen for the information of income tax collectors, reveal surprising totals. In some plants machine operators have received nearly $5000 in wages, and $2500 and $3000 for the year's efforts are commonplace figures that were attained last year by thousands of workers in casting plants. Few crafts are paid so well and not many vocations hold out the inducement for maximum effort and application as that offered by foundry employment on a piecework basis. It is an unwritten law in piecework shops that when a price once is set it is never changed, and in appreciation of this, records of production are made and broken by new high marks that never were believed to be possible of accomplishment. Nor have these increased wages been without compensation for the employer. Production is increased without unnecessary addition to the equipment, thereby reducing the overhead and other fixed expenses. Furthermore, this has relieved the labor situation in many of these shops, and the reputation for high wages is an attraction for the employes of other plants that impels their gravitation to these foundries. The introduction of piecework in the patternshop, always considered impossible of achievement, has been tried out successfully in one large plant. Not only are the patternmakers earning from $40 to $110 per week, but the number of employes has been reduced from an average of 90-odd to less than 50. The setting of prices for patterns is more difficult than for castings, and the employment of a skilled man for this work is essential. Wherever a fair rate has been set for cleaning and chipping castings, the earnings of the workers have been doubled and trebled and the output of the plant has been increased proportionately. Piecework as a war measure certainly has speeded-up production and increased output.—*The Foundry.*

DRY-AIR BLAST FOR HARDENING ICE CREAM

The hardening of ice cream is said to be one of the severest tests to which refrigeration is put to-day, the object being to extract a given number of heat units from each gallon of ice cream in the shortest possible time after it comes from the freezer, changing it from semi-solid to solid form. This was formerly done by means of ice and salt, and with the development of mechanical refrigeration the cans were submerged in cold brine. Considerable interest now attaches to the dry-air blast system of hardening ice cream, in view of the need for conserving ammonia and energy in mechanical refrigeration of all kinds.

The dry-blast idea is embodied in a system by which the cold air is blown around the cans by a power fan. Where there has been any failure of this system it has been nearly always traced to the rapid formation of frost on bunker coils, and success has depended upon stopping up leaks of air into the cooling room and providing good insulation. Air leakage is often unsuspected, and close examination of the plant for defects is recommended, with care in not using unsuitable buildings for dry-blast purposes.

CANVAS TUBING FOR MINE VENTILATION*

Metal tubing, with blower or exhaust fans, has long been used to supply air to dead ends where natural ventilation is impossible, and in driving smoke from such places. In Butte, Mont., canvas tubing has been used extensively and has many advantages not possessed by metal tubing. Improvements in the canvas itself, the jointing of sections and manner of suspension have increased its usefulness. A product now on the market is impervious to air, fireproof, and provides a system of jointing that permits the tubing to be put up or taken down in a few seconds.

CANVAS PIPE AS USED AT GRANITE MOUNTAIN SHAFT PREFERRED TO GALVANIZED TUBING

Deepening the Granite Mountain shaft of the North Butte Mining Co., Butte, Mont., from the 3100- to the 3700-ft. level was begun in 1916. Satisfactory progress was made for a few months, but air conditions became poorer with depth, and the best workmen left. The Granite Mountain is a downcast shaft with a good supply of air on the 3000-ft. level. A fan with galvanized tubing extending from the 3000-ft. level down the shaft, through the pump compartment, had been considered. But the drawbacks and disadvantages of the galvanized tubing were such that the engineers in charge decided to try a canvas tubing that was placed on the market about the time that the work on the shaft was begun. No means of joining sections were attached to the tubing and connections were made by slipping two ends over a wide metal hoop and holding the canvas in place by wiring it there. When two lengths were joinend in this way, a comparatively slight weight could pull the sections apart. Probably concussions have worked the same result.

RING JOINTS AND TENSION BANDS

Later a joint that not only supported the canvas, but a greater load, was used. This was made by attaching two rings of the same size, either of which may be put within the other by contracting one ring; it is reversible and can be taken apart or put together while the fan is running. The canvas which covers the fan is running. The canvas which covers the ring, being sewn in at each end of each length, acts as a gasket and prevents air leakage. In drifts and crosscuts, tension bands similar to the suspension ring used in shaft work are put over the joints at required intervals and slack in the tubing is taken up. Supporting rings, made from galvanized iron, were put over the joints and hung in the shaft by means of wires. After the installation of the tubing and the start of the fan, the best shaftmen were back looking for a place in the shaft, showing that working conditions had improved.

SHAFT PROGRESS MORE THAN DOUBLED WITH FLEXIBLE-PIPE INSTALLATION

August, 1916, progress amounted to 132 ft. against 50 ft. in July and 60 ft. in June, and the 20-ft. sump below the 3700-ft. level was cut in a few days in September. By using pieces of varied length, the tubing was kept as close to the bottom as the shaftmen wished it to be. In adding lengths the lowest, or blasting piece, was always removed and a new length placed above it. No great difficulties were encountered in the use of the tubing in the shaft. Occasionally the supports had to be lowered because of the stretching of the canvas; a few holes where the tubing was cut by flying rocks had to be sewed up, and it was necessary to start the fan after it had been stopped to hang the lines for timbering. Velocities of the air taken at the discharge averaged over 5000 ft. a minute. Rock temperatures in drill holes on the stations at the 3600- and 3700-ft. levels ranged between 100° and 105° F. A No. 4 Sirocco fan blowing through a 16-in. tubing was used, but this was larger than necessary.

TUBING USED IN CROSSCUT WITH BREAST 2100 FT. FROM AIR SUPPLY

The success in the ventilation of the shaft prompted the management to put a fan and some tubing in a crosscut being driven from the shaft. Conditions here were different, as water temperatures taken near the breast gave 65° F. While this is satisfactory as a working temperature, the accumulation of powder gas at the breast made it impossible to keep a full shift working, and rounds were repeatedly lost, so that the problem was not to cool the place but to clear it of smoke. The breast was 2100 ft. from the nearest supply of air—an upcast raise with a temperature higher than that of the breast of the crosscut. A fan house was put up over this raise, and 16-in. tubing extended in 1500 ft. to a booster fan. From this point the air was sent through another tubing to the breast. The joints between sections were the same here as in the shaft, but the method of support was different. A messenger or suspension wire (No. 8 galvanized) was stretched, the ends being fastened to stulls in the crosscut. At points from 25 to 40 ft. apart sprags were put up, and the wire was stapled to them to prevent sag. In the hem of the tubing, two grommets or eyes were inserted at three- or four-ft. intervals, and in these were fastened wire clips or hangers. By means of these hangers, the tubing was rapidly hung to the messenger and made fast by bending the hangers together. Between the sections a tension band similar to the suspension ring used in the shaft was placed over the joints, and when the slack was taken up it was wired to a clamp that held the messenger wire and prevented the tubing from drawing back. The fan delivered, when running, about 2500 cu. ft. per min. at the end of the line.

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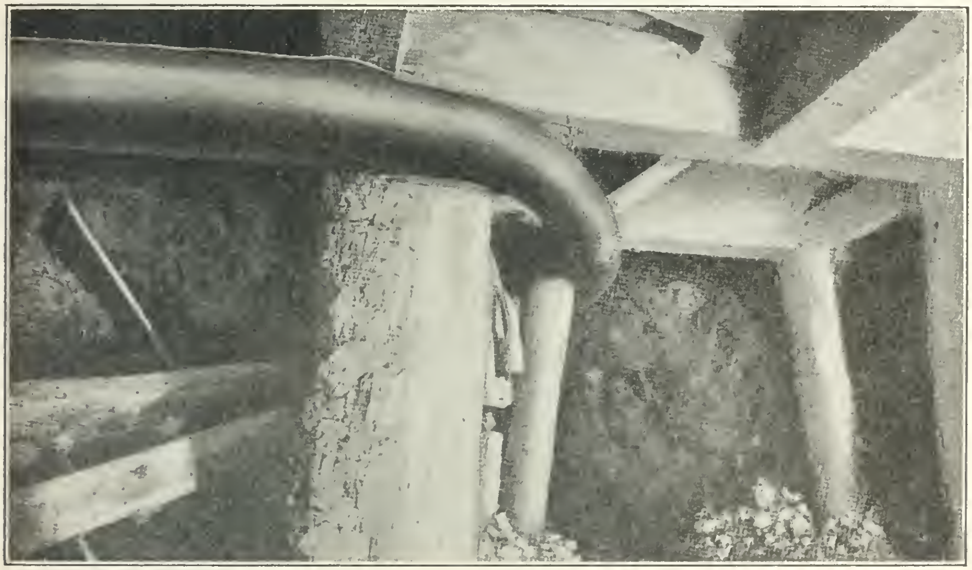
*From Paper by L. D. Frink, Feb. Meeting A. I. M. E.



CANVAS TUBING NORTH BUTTE MINING COMPANY

WATER CONDENSATION IN TUBE REQUIRES ATTENTION

The next morning it was found that each low place in the tubing was weighted with water, caused by the condensation of the air in cooling. Conditions at the breast of the drift, however, were much better than they had been, and the shift could easily work there. The sections were then disjointed and the water was drawn off. It was evident that the condensation could not be prevented, but by placing grommets in the bottom at both ends of each section, and keeping these corked, air leakage would be stopped, and by shutting down the fan for a few minutes each morning the ditch man could run all the water to the ends, pull the corks, tie up a short section and move on to the next joint to do the same. By the time the last sections were drained, he could start back along the line untying the canvas and replacing the corks. All would then be well for another 24 hours. Later the booster fan was not necessary, and the tubing was connected straight through, making, before the crosscut was finished, a 2400-ft. line. Conditions at the breast of this crosscut could not be made entirely satisfactory, because of the poor supply of air that had to be used, but the place was put in such condition that a round was seldom lost and the men remained, with but few changes, until the crosscut was complete.

When holed through to the Rainbow shaft, the crosscut was a mile from the Granite Mountain shaft, the source of the air supply.

This was the first ventilating air line that had been run in a crosscut, and the tubing conformed easily to the bends. Where galvanized pipe would have been hard to install, because of jutting rock or slight bends, the canvas passed them in smooth curves. Elbows to fit any angle were easily made by cutting the tubing to pattern, as a tinsmith cuts elbows, and sewing the two ends together.

REMOVAL OF BLASTING PIECE PREVENTS INJURY TO PIPE DURING BLASTING

In this crosscut some difficulty was experienced with the leading lengths until a successful blasting piece was made. This piece was made up with harness snaps fastened to ears sewed to the hem of the tubing, so that it might easily be put up or taken down. Before spitting a round of holes, this piece was detached and carried back to a safe place. This would leave the discharge far enough removed from the breast to be safe from flying rocks and the effects of concussion, and still close enough so that the smoke would quickly be driven out. When the next shift came on they would replace the blasting piece so that the air might blow directly on the workmen.

On the 3,000-ft. level good air was supplied to the breast of a drift by means of a No. 2½ Sirocco fan blowing through 500 ft. of 10-in. tubing. In this length there was one place where the water ran on the tubing in streams, but the canvas showed no ill effects from the bath. The cost per foot of driving was reduced about 50% in this drift, and no difficulty was experienced in keeping men. On the 3200-, 3400-, and 3600-ft. levels, considerable use has been made of the canvass tubing in the crosscuts. Rock temperatures on these levels are high, being 100° F. at the 3200-, 102° on the 3400-, and 104° on the 3600-ft. level, but as yet a separate fan has not been put on each of these levels, and all the air is supplied by a No. 6 Sirocco fan blowing from the 3000- ft. level. An air box has been put in one corner of the pump compartment of the shaft. At each level, the box is tapped and direct connection is made to the flexible tubing that runs to the breast of the crosscut. In spite of the high rock temperatures, the working conditions at the breast have been comfortable, and by having in each working place a number of short lengths, the men can bring the lead piece as close to them as they wish. When the short lengths are all in use, a long length is sent down to take their place. This order of changes is repeated as the work progresses.

TUBING IN RAISES BOXED FOR PROTECTION

Ten- and 12-in. tubing is used on these levels. By its use, it is found that the tension rings, used in connection with the clamp that grips the wire, and of course the clamp too, are not necessary on the smaller tubing. When they are not used, the clips that are bent around the wire messenger to support the tubing must be carefully tightened. More care must be exerted in the use of the canvas tubing for ventilating raises than in crosscuts or drifts. With high rock temperatures, it will be found that added advance and the consequently diminished cost will repay amply the time spent in placing and protecting the tubing. In all the vertical parts of the raises, it is found necessary to box the tubing for protection from falling rocks. These boxes need not be air-tight and can quickly be thrown together out of 1-in. material. At the offsets the tubing need not be covered. The discharge from the top box must be covered with a screen to keep falling pieces from going down the tubing, and it must be especially well protected when blasting.

SUFFICIENT VENTILATION NOT ASSURED BY PROXIMITY TO AIR SUPPLY

The proximity of a current of good air does not necessarily mean a good place to work. A stope was started on the 2600-ft. level directly over a crosscut used as a main air course of the level. On the first floor the conditions were good; on the second floor the stope was a poor one to work in, and the third floor was so hot that little was accomplished, though neither end of the stope was 50 ft. from the main air course, but no natural ventilation was obtainable. A No. 4 Sirocco fan with a 20-hp. motor was placed at the crosscut and the air was taken through a 16-in. tube up a manway and turned directly on the men in the stope, which made it a good place to work. Stopes such as this must often be worked until connections can be made to other levels, and the use of blower fans seems to be the best solution of the problem presented by such places. In one stope with ample connections between levels a No. 4 fan and 16-in. tubing completely reversed air currents, with a resulting drop of 15 degrees. This result was accomplished without causing any apparent ill effects in the other workings. Often places are encountered in both stoping and development where artificial ventilation is needed only while a raise is being put up, or a cross-cut or a drift extended. Such work may take a month or less. Normal conditions may be such that it is impossible for men to work in these places. The short period of time necessary to have the fan blowing before natural ventilation can be obtained does not warrant the building of a concrete foundation. Wood foundations have been eliminated almost entirely for all electrical machinery on account of fire risk. As motor haulage with direct current is used almost entirely, and the trolley lines reach almost every part of the mine, some No. 2 and No. 3 direct current fans, placed on heavy plates, have been mounted on trucks and so arranged that they may be turned to any horizontal angle with the trucks, and makes satisfactory installation for use in these places.

The experience of the North Butte Mining Co. with canvas tubing has extended over a period of more than a year and has been tried out in all sorts of working places, and in every case has justified the installation. Canvas tubing is more satisfactory than metal tubing, and those who adopt its use are not likely to return to galvanized iron.

THE GARAGE DANGER

Notwithstanding all warnings against running a gasoline motor in a closed garage many deaths by suffocation are reported every year when cold weather comes on, and they are usually of people who are supposed to be reasonably intelligent. For the benefit of automobile users we will repeat the warning not to run an internal combustion motor in a closed garage under any circumstances. Contrary to the general impressions the gas that produces such sudden and fatal results, has no odor whatever, and a surprisingly small percentage of the gas is fatal. Moreover, in most cases, the gas gives absolutely no warning of its presence and the victim has no chance, the first sign of its presence being a sudden, total and helpless collapse.—*Scientific American.*

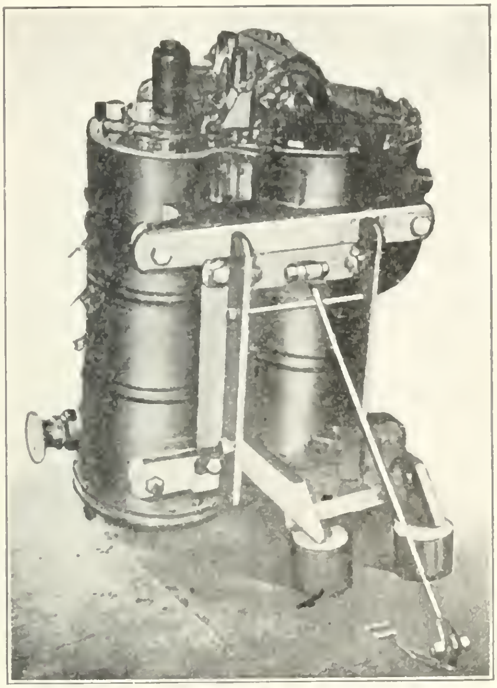


FIG. 1. COMPRESSOR BOLTED TO TABLE

AIR BRAKE COMPRESSOR REPAIR TABLE

A particularly substantial and useful table for the rigid support of air compressors of all sizes while under repair has been designed by F. P. Brotherton and J. H. Hahn and is being used with good results in the Norfolk & Western shops at Bluefield, W. Va. The following description was written by Mr. Hahn for the Railway Mechanical Engineer.

This device is made up, as shown in the illustrations, of a hinged table mounted on the upper end of a piston rod, the piston and cylinder of which are beneath the floor. A movable arm, connected at one end to the floor and at the other end to the free side of the table, causes it to change from a vertical to a horizontal position when the piston rises.

In operation the compressor is up-ended and bolted to the table as shown in Fig. 1, the air being released from the cylinder. When it is desired to raise the compressor, the air is turned on and the piston begins to rise. This lifts the lower end of the table, but the upper end is restrained by the movable arm so that it gradually tips until with the piston in its extreme upper position, the table and compres-

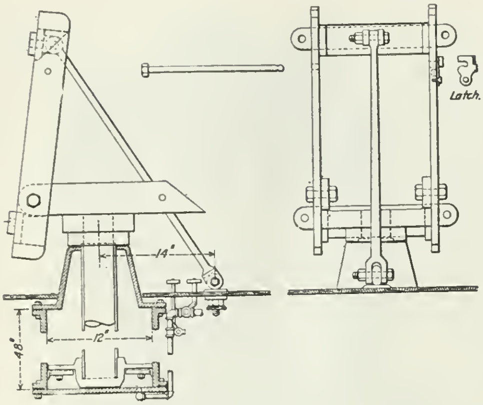


FIG. 2. SKETCH OF TABLE

sor rest horizontally as shown in Fig. 3. The table is then locked by means of a long pin extending through the frame at the top of the plunger. The arm is removed so it will be out of the way of the repair man. Before going ahead with the repair work, a sheet iron sleeve is put around the piston rod, and the cylinder air pressure released. The sleeve then holds the pump at the required height and prevents waste due to air leakage by the cylinder packing leather. If more convenient for the workman, sleeves of different lengths may be provided, which with the arm attached will hold the compressor at any angle desired, and by providing auxiliary brackets which may be applied to the table it may be used for making repairs to all sizes of compressors. The piston rod is turned to a loose fit in the cylinder sleeve, as of course there is never any air pressure above the piston. The cylinder used was an engine-truck, pit-jack cylinder 12-in. dia. and 48-in. stroke.

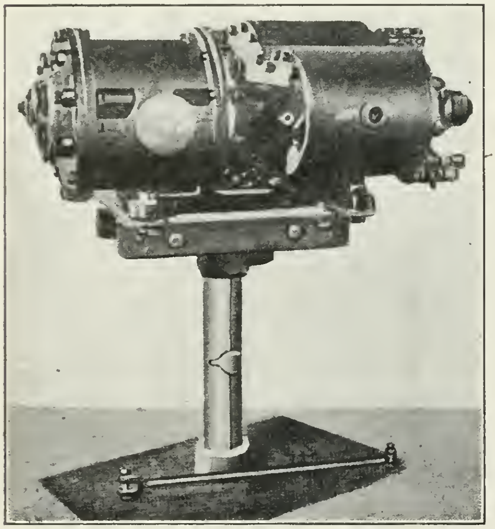


FIG. 3. READY TO BE OVERHAULED

The use of this table does away with the necessity for air hoists, runways, chain falls or blocking. There are no legs to get in the way of the repair man and the compressor may be set to work upon at any height and any angle. Also on account of the whole arrangement being rigid, bolts and nuts, etc., may be tightened up with all the force required. All of these advantages and good features combine to make a repair table which has given good satisfaction at the Bluefield shops, and in fact have actually increased the output or the number of compressors repaired per month.

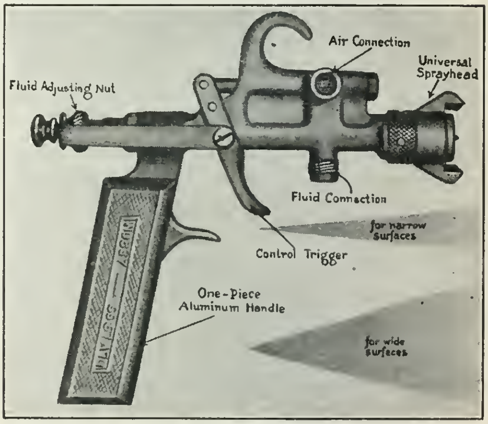


FIG. I

THE AERON PAINT SPRAYING SYSTEM

Among the various methods of applying paint in the form of spray with compressed air as the impelling medium is now to be included in the Aeron system developed by the De Wilbirs Manufacturing Company, Toledo, Ohio.

The responsible portion of the apparatus employed is illustrated in Fig. 1. The nozzle has a pistol grip with the control trigger always under the operator's finger and within four inches of the spray head. The delivery of the spray head gives a thin, flat flow which may be either horizontal or vertical, and wide or narrow according to the requirements of the work.

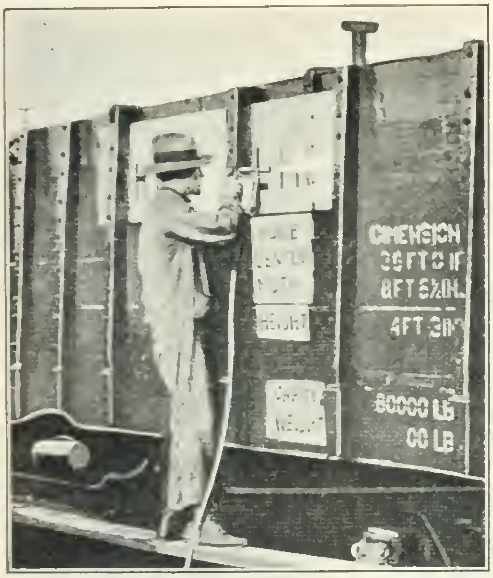


FIG. 2

There is a paint tank of suitable capacity with regulating head inlet connected by ½ in. air hose to the air supply. One or more nozzles may be connected to the tank by ⅜-in. hose and with a pressure regulator and the fluid adjusting nut on the nozzle the flow is controlled to meet varying conditions of size or nozzle, viscosity of paint, height of delivery, etc. These sprayers are in successful use for a variety of work on railroads and elsewhere. Fig. 2 shows the operation of stenciling the lettering on a freight car and Fig. 3 shows, not very clearly, the painting of the truck.

HEATING OVERDONE

It is stated that a means has been discovered for keeping airmen warm at great altitudes by providing them with electrically-heated clothing. Should this become an easy applied system we may do away with heating in our buildings, as our collars, handkerchiefs, underclothing, and other garments may supply us with all we need, says a note in the *Builder*. We may in the future be as comfortable with the temperature below zero as we are now in a well-heated building, and the bath of the future may be warmed to any desired heat if we place it in the neighborhood of a well-filled ward-robe.

If we want to eat an ice it may be necessary partially to undress, since the proximity of a well-dressed man or woman may reduce the ice to liquid before we can eat it. Assuming the control of temperature to be within our grasp it is possible we shall have automatic contrivances by which our clothing will give out a greater or less degree of heat. A suit will be guaranteed to preserve a temperature of 60 deg. for the wearer, the outer air being anywhere between 16 deg. and 40 deg. A suit to give a greater temperature would presumably cost more, irrespective of material. When the discovery has been fully developed the heating engineer will find his occupation gone.—*The Engineer.*

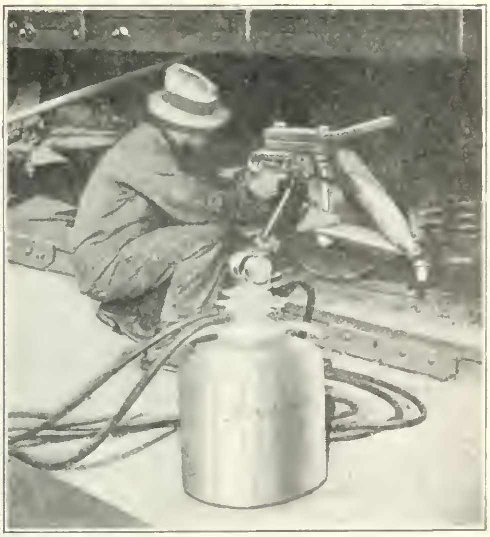
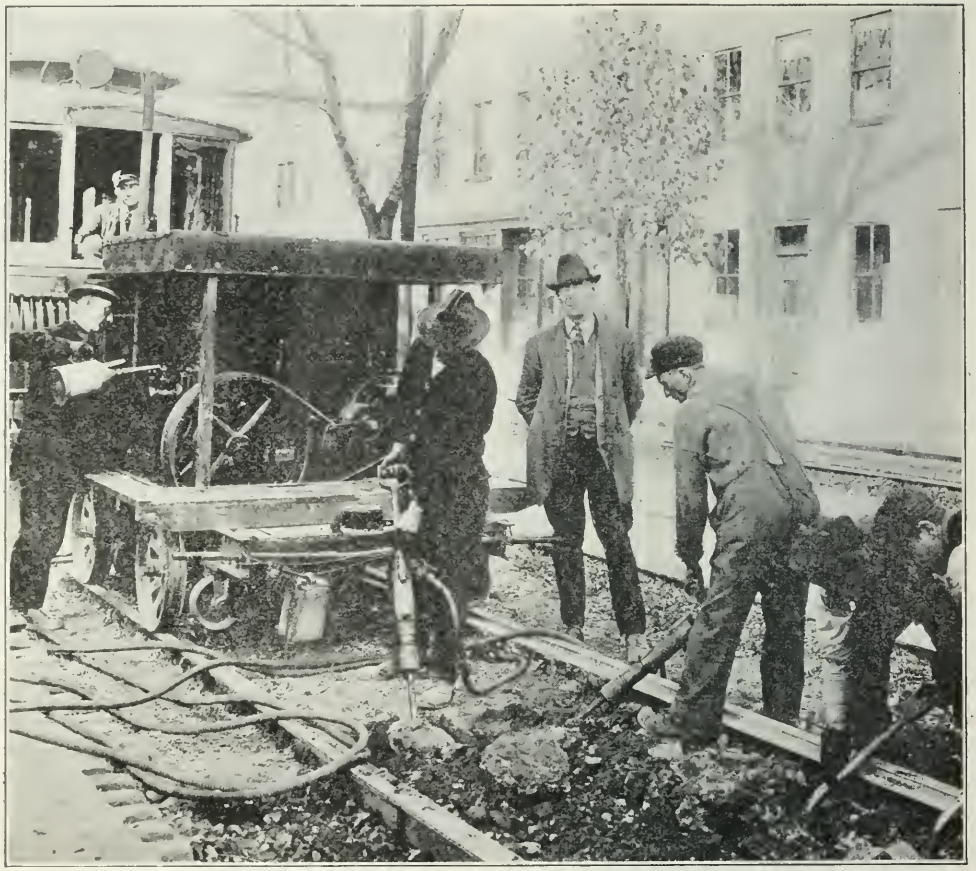


FIG. 3

ALL THE WIRE GAGES

The Bureau of Standards of the Department of Commerce has issued a new publication entitled "Combined Tables of Sizes in the Principal Wire Gages" (Circular 67), this table combining in one series the sizes in the American (B. & S.), Steel, Birmingham (Stub's), British Standard and Metric Wire gages, arranged in order of diameters or sizes. It gives the diameters of all of the gage numbers in these five systems, in mils, inches, and millimeters, also the cross-sections in square mils, circular mils, square inches and square millimeters. This paper is now ready for distribution, and copies may be obtained upon application to the Bureau of Standards, Washington.

Canadian manufacturers now produce 800,000 complete shells every week, which is more than was produced, before the war, by any nation except Germany.



PORTABLE AIR COMPRESSOR FOR ELECTRIC RAILWAYS

The half-tone above shows a machine in service which saves a large amount of manual labor, a motor driven air compressor mounted on a standard gage truck and operated from the street trolley circuit. It supplies the motive power for the tampers, track drills, chipping hammers for toothing out bricks, air blasts for cleaning rust from structural steel, and many other pneumatic tools found serviceable on track and road work.

The outfit consists of an 8 by 6 inch Ingersoll-Rand compressor driven by a 15 H. P. 550 volt Westinghouse direct current motor with starting rheostal, knife switch and fuses. It is hauled to the job by a trolley car and when connection is made to the trolley wire, it is ready for use. Two tie tampers, chipping hammers, or other tools can be used at the same time. Four small wheels under the truck at right angles to the track-wheels, permit the outfit to be run off the track on heavy timbers.

In a test made under continuous traffic conditions it was found that the cost of the tamping with this machine was one-half that of hand tamping, and better results were obtained, as no second tamping was required on account of settlement under traffic. Further, it was found that two men with the pneumatic tampers could do the work of ten laborers.

Equally satisfactory results were obtained in tearing up concrete, as shown above, in clearing the rust from bridge rollers and seats, drilling bolt and tie rod holes, picketing and cleansing bricks, etc.

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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The Treasury of the United States has a great deal of money to raise and it can not be raised by bankers alone, says Secretary McAdoo. The banks of this country can not alone sustain America's needs in this war and extend to our allies the essential aid which they must have to continue the war. The rich of this country can not do it alone; the men of this country can not do it alone; the women of this country can not do it alone; but all of us, the people of the United States, disregarding partisanship, forgetting selfish interests, thinking only of the supremacy of right and determined to vindicate the majesty of American ideals and secure the safety of America and civilization, can do the great and splendid work which God has called upon us to do.

THE BUOYANCY BOXES

Notwithstanding the fluctuations of our hopes and the recurring assurances of the overcoming of the submarine and its deadly torpedo, the menace is still most formidable and the actual destruction little checked. There can be no hope of any satisfactory ending of the war while the submarine still flourishes.

There can also be no hope that the submarine can be annihilated and driven from the seas by any monstrous and overwhelming invention. Anything with any promise of minimizing the destructive effects of the torpedo or the floating mine is to be accepted for what it may be worth, and that, we take it, is the status of the buoyancy boxes

This levitation device for keeping merchant ships afloat after being torpedoed is now sufficiently understood by the public and little more is to be told than is contained in the article in our present issue. Whatever may be the merits and whatever may be the ultimate success of the device it comes to us in the way such an invention should come: from one who knows much rather than from one who knows little about the actual requirements and the practical conditions which must be met. Mr. Donnelly is a marine engineer of high standing and large experience, and such as he should be the one most likely to be able to suggest the means of solution or even partial solution of the problem.

There is much satisfaction to be found in the knowledge that the device is in the way of immediate demonstration. The thing to a considerable extent demonstrates itself, and no drydock trials, that have been suggested, or anything of that kind could give much additional assurance.

The only way to certainly prove the practical saving power of the buoyancy boxes is to have the Lucia go into regular service as soon and as actively as possible, and even then we can hardly say that she should seek the most dangerous waters, or put herself in the way to actually invite attack, but she should take her chances and results might be expected to follow.

Notwithstanding the publicity which has been given to the equipping of the Lucia, it would seem that her location and movements in the near future should be as secret as possible, and so we may not expect to know much of her comings and goings, but we must continue to wish her good luck, and if there should be full warrant that the buoyancy boxes are of saving efficiency the equipping of other ships with them could be accomplished more quickly than could any other arrangement thus far proposed.

With regard to this invention as applied upon this particular ship, our attitude is certainly embarrassing and not clearly definable. It would not be easy to say just what we would wish. Certainly we would not wish to have her struck and sunk. Our confidence may be far from absolute that she could not be struck so that she would certainly sink. We can only say that we would wish that something might happen to satisfy us all.

THE TANKS*

On a certain Friday in September, 1916, after two years of fighting, when it might have been thought that human ingenuity in the art of killing had been exhausted, a fresh engine of war was suddenly sprung upon a world sick of hearing of new methods of slaughter. A day or two later, so soon as the newspapers were able to give some information about this development, the word "Tank" was on all British lips, and since that moment has probably been spoken, written and printed more often than during the whole previous period since its incorporation into the English language.

A word of general description and a few more upon the functions of the Tanks. They are powerfully-engined armed automobiles, enclosed in a bullet-proof casing for the protection of their crews. Propelled on the caterpillar principle, they possess considerable powers of travelling over rough ground, both in crossing trenches, craters, and other cavities, and climbing over raised obstacles, such as parapets; can tear their way without difficulty through wire entanglements, can uproot largish trees, and can throw down the walls of ordinary dwelling houses. Nevertheless, in spite of their elemental strength and apparent clumsiness, in the hands of skilled drivers they are as docile as trained elephants under their own mahouts.

They are divided into males and females. The male is par excellence the machine-gun hunter and destroyer. He carries light, quick-firing guns capable of firing shells, and is intended to be to the machine-gun what the torpedo-boat destroyer was designed to be to the torpedo boat, or the lady-bird is supposed to be to the aphis. The female, which, in accordance with the laws of Nature, is the man-killer, carries nothing but machine-guns for employment against the enemy personnel. Her special role is to keep down hostile rifle fire, to beat back counter-attacks and rushes of infantry, and to act generally as a consort to her lord and master.

Both sexes, however, are heavy weights endowed with great brute force, and share, in common, the attribute of being able to roll out and flatten machine-guns and their emplacements. Both, therefore, act as protectors to infantry, insomuch as they can destroy or "blanket" the one thing which has, so far, proved its greatest bugbear in the attack. Moreover, every Tank that goes forward, whether actually moving or disabled, assists the infantry near it in another way. It bulks above them and is the centre of attraction. It acts as a magnet for the bullets of the hostile machine-guns, and collects them to itself as Arnold von Winkelried is supposed in 1386 to have drawn to his own body the spears of the Austrians at the battle of Sempach. Every bullet that clangs against its steel

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*From an admirable paper by Colonel E. D. Swinton, C. B., D. S. O., Royal Engineers. originally printed in *The World's Work*.

sides is one less aimed at the infantry. Every silvery star splashed on its hide is the signature of one that has not drilled its way through the body of an infantry soldier.

To be the nurse, protector and backer of the attacking infantry, who, in the vernacular, "always get it in the neck," was the motive underlying the action of the new arm. As it was expressed in the exhortation given to the officers and men going forth to take their machines into battle for the first time, whatever mistakes might be made, whatever mischances might befall, if the Tanks gave reason for their comrades on foot to thank God for their presence, they would have justified their existence.

That the Germans appreciate the significance of the new development is clear from the instructions issued, and the elaborate protective measures taken by them. And in spite of the ridicule usually poured on the new weapon by their newspapers—the object of which is plain—articles do occasionally appear which sound another note. For instance, Lieutenant-General Baron von Ardenne stated in the "Berliner Tageblatt" that:

"These powerful armoured cars, which were first used by the British, are undoubtedly the most wonderful weapons which modern tactics have revealed in warfare. . . ."

A parting message, and a grip from a friendly hand. This little book may perhaps be read by some of the "boys" from Massachusetts, Oregon, Texas, Pennsylvania, or other States of the Union, who, as members of the infantry of the United States army, may find themselves in the not distant future scrambling across No Man's Land alongside their comrades of the Allied forces, who have already "been over." For them it may perhaps be permitted without presumption to add a word of counsel from one who, though not an infantry soldier, knows something about it. To the time-worn advice of: "Johnnie, get your gun," he would merely add: "And bring your Tanks."

WORKERS WANTED FOR THE AVIATION SERVICE

The Signal Corps authorizes the following statement:

Ten thousand machinists, mechanics, chauffeurs, and other skilled workers are needed at once by the Aviation Section, Signal Corps.

The present call for 10,000 men is to fill an immediate need and may be regarded as the precursor of others as the service is being built up. Even at that the actual strength of the service today is over one hundred times what it was on April first last year.

The dependence of the Air Service on the most highly skilled men is being brought out more emphatically with every week of development. Where in the first rush there was little experience to indicate this fact, it has since developed that practically 98 men out of every 100 in the service must be skilled in some branch of work.

Airplane work has been wholly new and unfamiliar to American mechanics, who have been taken from other trades and converted hastily into workers on the most delicate kinds of jobs. It has been necessary for both officers and men to learn very largely by experience. At the same time a degree of care and attention not usually associated with American quantity production and methods has been required, as great watchfulness is essential to prevent any plane leaving the ground in imperfect condition.

Secretary Baker recently expressed this situation as follows:

"The great problem now remaining is to secure the thousands of skilled mechanics, engine men, motor repair men, wood and metal workers needed to keep the planes always in perfect condition. This great engineering and mechanical force at the airdromes, flying fields and repair depots, both here and behind the lines in France, is a vital industrial link in the chain of air supremacy. Without them the planes turned out would be useless and the flyers helpless."

Men registered in the draft may be inducted into this service by applying to their Local Draft Board. Men not registered may enlist at any Recruiting Office. Further information may be had by applying to the Air Division, Personal Department, Washington, D. C. In either case they will be sent to San Antonia, Texas, for segregation by trades, followed by a brief course of instruction at the flying fields or at various factories and organized into squadrons mostly for service overseas.

The present call is especially for: Machinists, auto mechanics, engine repairmen, gunsmiths, chauffeurs, carpenters, blacksmiths, tinsmiths, cabinet-markers, electricians, coppersmiths, sheet metal workers, propeller makers, wireless operators and constructors, tailors, tent-makers, sail-makers, truckmasters, vulcanizers, welders, and makers, repairers and installers of: Magnetos, ignition systems, cameras, watches and clocks, instruments and typewriters.

WAR FUEL

"If, according to Dr. Burton, chemist of the Standard Oil Company, the 1917 production of gasoline will be 2,500,000,000 gallons, of which he estimates 2,000,000,000 gallons will be required for American automobiles, it follows that but 500,000,000 gallons will be available for use by military trucks and for export to the allies," says F. Nelson Carle, former secretary of the Motor Truck Club of America.

"With all due respect to so eminent an authority, I venture to raise the point that nearer 50 per cent. of our next two years' production of gasoline will be required directly or indirectly for war purposes. Fortunately for the passenger car owner, other fuels are being adapted to the use of farm tractors and gas engines so these agricultural necessities will not compete with him for fuel as heretofore.

"But what about the submarine chaser, the gas-driven scout cruiser and the motor boat patrol? A good, big 'chaser' of the type now building, perhaps by the hundreds, certainly by the score, has two and in some cases three 250-horsepower motors which consume, in action, 30 gallons of gasoline per hour per motor. If we have to supply fuel for such boats abroad as well as in our own waters, 500,000,000 gallons will not supply such thirsty hornets throughout the war without starving either the 70,000 motor trucks needed by the army or the 60-horsepower touring car.

"Fortunately millions upon millions of gasoline units can be conserved for needed tasks through the use of electricity as a fuel, particularly in city trucking. A large proportion of electricity is made by water power, so that even coal is not needed to increase the supply of this fuel in some sections. Granted coal is used, the cost of industrial electricity is so low that it forms one of the cheapest means of propelling motor-driven city vehicles.

"The war practically denuded European cities of petrol vehicles in the first year of the conflict, and the relatively small number of commercial electrics then available were in great demand, particularly as horses had also been commandeered.

"Since that time the demand for electrics has been greatly augmented, resulting in a 600 per cent. increase in England alone. The leading railroads—among them the Midland Railway, which has purchased over 100 electric trucks, many of them American built—have bought heavily. All over Great Britain the demand for electric lorries, and in fairness to all, for steam vehicles, too, is said to be greater than the supply. Gasoline (petrol) vehicles are still being built or imported in large quantities, but almost wholly for military purposes. The mortality among trucks pounding over the shell-shattered roads of France and Belgium is almost unbelievably high.

"Much the same situation obtains in France, Germany and Austria, the electric being given the preference in transporting mail and merchandise about the cities or between industrial centres By its use gasoline is conserved and many wartime economies made possible, among these the utilization of women drivers.

"Even well informed business men do not always understand why electricity used for recharging truck batteries can be purchased for less than the electricity for an office building or residence. The reason is obvious if they will but consider the simplest of laws—commercial demand. When the business day begins facotries, stores, elevators and other units make their requisition upon the 'central station,' as the main plant of the electric light company is called, and by 11.45 a. m. the load has reached a tremendous peak.

"During a short sunlight day, as in December, the demand upon the central station around 5 p. m. is frequently about all the machines that make the energy can stand. There is a small 'valley' during the noon hour, but, generally speaking, all the current manufactured during the day is consumed. Naturally any one adding to the 'day load' as it is called, should almost pay a premium for his current.

"But at night all this is changed. Then many of the big generators are idle, others producing but half their capacity. By midnight a few residences, hotels and electric signs are all that is left to consume current. During the 'off peak' hours, then, say from 7 until 7, the central station is hungry for business and the man with an electric truck or a fleet of them with depleted batteries is as welcome as the proverbial spring flowers.

"Then is when he can buy electricity for as low as one-third of what he might pay during the peak hours of current demand. So low is this rate in many cities, including Boston, that sufficient current to keep a 5-ton electric truck running all day can be purchased for what it costs to buy four gallons of gasoline, or to feed a single horse for 24 hours.

"From the standpoint of motor trucking, then, electricity would seem to be the logical fuel for such trucks as confine their activities largely to the city and immediate suburbs. Intelligent conservation of petroleum and its derivatives is as important as that of grains and other products of the soil."

A RED LAMP WITHOUT FLAME

This interesting little lamp works on the incandescent principle, and is specially useful for tourists. Any alcohol lamp, or a small bottle provided with a round wick, is used. The wick is spread out in a bunch just above the opening of the bottle, and when wet with the alcohol, place upon it the Barden "photo-incandescent cone," then light the wick, burn for five minutes, blow out, and the small piece of the substance will continue to absorb the alcohol and burn with a red glow without being consumed.

OIL FOR AIR COMPRESSORS

In the course of a paper on the "Chemistry and Examination of Lubricating Oils" read before the Diesel Engine Users Association, Mr. Elliott A. Evans made some remarks on the quality of oil required for use in air-compressors.

He said that the Pennsylvanian oils are the only ones moderately stable when subjected to the action of highly compressed air, and then only at moderate temperatures. At elevated temperatures the oil cracks, giving rise to lighter oils which in their turn crack into still lighter oils. During the cracking carbon is deposited, and some extremely unstable hydrocarbons, probably of the olefine series, are formed which decompose with explosive violence. It is quite conceivable that the explosion in an air-compressor at Smithfield occurred through the production of these unstable bodies, and that the vapor of the light oils was exploded by their detonation. That the explosion was caused by the ignition of oil fog may be a very convenient working hypothesis, but it is a little difficult to understand how ignition was effected.

BLOWING DUST FROM MACADAM

In preparing macadam roads for the application of tar or oil, it is generally desirable to remove all dust from the top of the road in order to permit the bituminous material to penertate the stone. If a portable air-compressor is available the dust can be blown off the road. This is the best way, for it cleans the upper interstices, while brooming only packs the dust into them. One plan is to attach to the end of the air-hose a T-shaped set of pipes formed of a tee and three pipes, a row of small holes being drilled in line in the two pipes that are fastened in the opposite openings of the tee. This set of pipes is held in the hand or may be fastened under the wagon carrying the air-compressor so as to come an inch or two above the road-surface.

NOTES

Lycopodium is a vegetable material which, before the war, was used for dusting or coating the molds in foundry practice, in order to prevent the sand from clinging to the castings. Lycopodium came exclusively from Russia and there is none available now. Experiments have showed that by a centrifugal process the dust, which is precipitated from the gas exhalations of the drying apparatus in the works where coal or ligite is briquetted, can be used successfully to replace lycopodium. The light particles of dust, which contain a large percentage of paraffin, have the same properties as lycopodium, as may be seen when water is poured upon them.

That there is more money in working for coal companies these days than in some of the learned professions is evidenced by the fact that Dr. Daniel Reese, of Summit Hill, Pa., has closed his dental offices and is now foreman of an anthracite coal stripping at No. 14 colliery.

A walkers' club has been started at Harrisburg, Pa. Every member pledges himself or herself to walk to and from work, if the distance is less than two miles. This pledge is to be kept in all sorts of weather. The movement is another manifestation of the queer turn which the thrift idea has received.

An American painter recently returned from the Orient believes that in the new renaissance in architecture which is to come after the war we are to have concrete skyscrapers brilliant with color. Needless to say, as a substitute for the dull gray of the average concrete construction, "pink tones, little green-shutters, red roofs and purples," as the architect predicts, would certainly be a gay and giddy change and possibly give American architecture a touch of Italy and the Orient.

Most of the artificial colors now produced have no counterpart in nature. The vat dyes, conspicuous since the war by their absence, are faster than anything obtainable commercially from the vegetal world.

The suffocating poison gas first used by the Germans is not chlorine as generally supposed but phosgene, which is a combination of chlorine and carbon monoxide. This powerful gas is an important factor in the manufacture of synthetic colors. Here is a case where a German peace product was immediately available for military offensive.

Aeroplanes for carrying mail are the subject of a call for bids recently issued by the Post-Office Department. The specifications call for five machines, each capable of carrying 300 pounds of mail a distance of not less than 200 miles, non-stop, maximum speed under full load, 100 miles per hour, minimum speed under full load, 45 miles per hour, climbing speed 6000 feet in 10 minutes, equipped with a 150-horse-power motor.

The Institution of Civil Engineers of London, England, on Jan. 2 completed the hundredth year of its existence, having been established in 1818 at a meeting of eight engineers at the Kendal Coffee House in Fleet Street. At the meeting of the institution on Jan. 8 a statement commemorative of the founding of the institution was presented, war-time conditions precluding more formal celebration of the centenary.

Heavy pneumatic hammers were used to rivet circular reinforcement sleeves to the outside of a 48 to 54-in. pressure pipe for the Jordan river hydroelectric plant at Vancouver Island, B. C., after the pipe had been connected in the trenches. The riveting was so heavy that it was necessary to relieve the operators by providing means to hold the hammers in position while the rivets were driven. This was successfully accomplished by attaching two heavy spiral springs to a collar clamped on the hammer and to opposite ends of an adjustable chain encircling the pipe and thus holding the hammer in position under tension making it necessary to only guide and control it.

A fireman went to his chief and said, "I am saving you a ton of coal a day over what you have been burning, and I think I should have more pay." The chief replied, "If you are not shoveling as much coal as did the old fireman, you are doing less work, so you should not ask more pay for less work." There are such men in the world.

A new metal known by the registered name of Bario has been put upon the market by the Bario Metal Corporation, New York, as a heat and acid-resisting material. The manufacturers claim that this is the only commercial metal of its kind that does not rust, tarnish, corrode or deteriorate. It is, they state, non-magnetic and remains clean and bright and is not attacked by sulphuric, nitric or muriatic acids, resembling in this respect gold and platinum. The melting point of Bario is high, beginning at 3100 deg. Fahr. and increasing according to the grade of metal mixture used. It is manufactured in nine different grades.

In one of his journals, Camille Flammarion gives the heights at which sounds from the earth are heard from balloons. The shout of a man was heard distinctly at the height of 1600 ft., the sharp note of a mole-cricket at 2500 ft., and the croaking of frogs in a morass at 3000 ft. At 3255 ft. a man's voice and the rolling of a cart were distinguished; at 4550 ft. the roll of a drum and the music of an orchestra; at 5000 ft. the crowing of a cock, the sound of a church bell, and sometimes the shouting of men and women. Nine hundred feet higher still he heard the report of a musket and the barking of a dog. The noise of a railway train penetrated to a height of 8200 ft., and the whistle of a locomotive engine to nearly 10,000 ft.

A world's flying height record of 23,048 ft., with a passenger aboard, attained in 1 h. 3 min., has been established by Flight-Lieut. Francesco Brak Papa, of the Italian Army on a Sia-Fiat biplane. According to the *Autocar,* the flight was made from the Turin aerodrome on December 14th, 1917, the machine carrying a useful load of 792 lb., and was officially observed. The rate of climbing was: 6,561 ft. in 5 min., 13,123 ft. in 15 min., 19,685 ft. in 37 min. 30 sec., 21,325 ft. in 45 min., and the maximum height of 23,048 ft. in just over the hour. This record performance was made with a 300 horse-power six-cylinder Fiat water-cooled engine, of the same type as that used for the flight from Turin to London. The previous height record with a passenger was 21,161 ft., made by the same pilot.

The United States Lighthouse Service is charged with the maintenance of aids to navigation along 47,192 statute miles of coast line and river channel. On June 30th, 1917, there were 5796 persons employed in the Lighthouse Service, including 122 in the teachnical force, 149 in the clerical force, and 5525 employees connected with depots, lighthouses, and vessels. During the fiscal year there was a net increase of 275 in the total number of aids maintained, the total at the end of the year being 15,223. Of them 5420 are lights of all classes and 588 are fog signals. The total number of aids in Alaska, comprising lights, fog signals, buoys and daymarks in commission at the close of the fiscal year was 416, including 159 lighted aids. During the fiscal year 1917 services in saving life and property were rendered and acts of heroism performed by employees of the Lighthouse Service on 160 occasions.

The Press Censor and we are very good friends, and he will forgive us for repeating a good little story at his expense. The National Ordnance Factory, of Leeds, issued, some time ago, an excellent and original souvenir, called the "Shell Magazine." An ingenious contributor wrote for it a poem on the familiar lines of "The House that Jack Built." It began: "This is the shell from Newlay; this is the fuse they always use in the shell that comes from Newlay," and so on. Now the Censor has made a rule that the site of a munition works must never be mentioned, so whenever he came to Newlay in the "poem" he struck it out and replaced it by "a factory." The result can be imagined. "This is the shell from a factory; this is the fuse they always use in the shell that comes from a factory," etc. Providentially, a big man at "munitions"—as the telephone girls call it—with a large poetic-sense was found to argue with the Censor, and the Censor gracefully gave way in deference to Art.—*The Engineer,* London.

A new record was made recently in the time consumed by a vessel in passing through the Panama canal. The former record was 5 hours 45 minutes, which was reduced to 4 hours 13 minutes by a northbound (Pacific to Atlantic) ship. Later, the record was again lowered by a vessel going south, which made the trip in 4 hours 10 minutes.

Next to Buffalo, no large city in America wastes as much water as Chicago with its 260 gal. per person per day. New York City uses only 101 gal. per person per day.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 29.

1,254,645. TRAIN-STOP. Willoughby Moulton Avery and John Bingham Booth, Greensboro, N. C.

1,254,650. RECIRCULATION SYSTEM. Chas. Bollinger, Chicago, Ill.

1,254,678. AIR-BRAKE APPLIANCE. Frank Goff, Camden, N. J.

1,254,693. METHOD OF COMPRESSING AN ELASTIC FLUID. Herbert Alfred Humphrey, Westminster, London, England.

1. The method of compressing an elastic fluid by means of liquid descending from a higher to a lower level or pressure, which consists in permitting a flow of said liquid until it attains velocity, then utilizing the momentum of the liquid partly to compress and deliver compressed elastic fluid, and partly to store energy in an elastic cushion to produce a reverse movement of the liquid and thus cause a fresh charge of elastic fluid to enter the region of compression.

1,254,781. VALVE FOR AIR-COMPRESSORS AND THE LIKE. George K. Davol, San Francisco, Cal.

1,254,834. SPRAYING APPARATUS. William P. Mott, Chicago, Ill.

1,254,921. AIR-SUPPLY TANK. Henry J. Meengs, Vriesland, Mich.

1,254,951. FLUID-OPERATED CLUTCH. Chas. M. Ward, Cleveland, Ohio.

1,255,018. PROCESS AND APPARATUS FOR THE SEPARATION OF OILS AND GASES. Philip Jones, Santa Maria, Cal.

1,255,063. DRAFT-GAGE. William H. Stevens, Altoona, Pa.

1,255,105. FLYING-MACHINE. Michael F. Morrissey, Muskegon, Mich.

FEBRUARY 5

1,255,130. SIPHONIC SYSTEM. Delavan V. Burrell, Rocky Ford, Colo.

1,255,141. MILKING MACHINERY. Norman John Daysh, Poughkeepsie, N. Y.

1,255,175. VACUUM-CLEANER. John Blake Kellogg, Orange, N. J.

1,255,186. MILKING - MACHINE CLUSTER. Meredith Leitch, Poughkeepsie, N. Y.

1,255,239. MILKING - MACHINE. Sebastian Sis, St. Paul, Minn.

1,255,278. AIR COMPRESSOR OR MOTOR. Robert G. Battin, Kansas City, Mo.

FEBRUARY 12

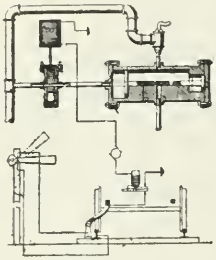
1,255,843. DRYING APPARATUS. John B. Adt, Baltimore, Md.

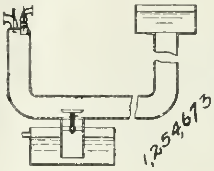
1. In a drying apparatus, a rotary drum having a material inlet and an air outlet at one end and a material outlet at the opposite end, an air-expansion chamber into which the outlet end of the drum extends and into which it opens, a heating jacket surrounding the drum and opening into the air-expansion chamber, said jacket being carried by the drum and rotatable therewith, an air heater, and means for delivering air from said heater into the aforesaid jacket.

1,255,855. AIR CHAMBER AND DRAIN STORAGE PUMP. Carl F. Brandenberger and Martin W. Reuther, Fort Madison, Iowa.

1,255,875. AIR-PUMP. Arthur G. R. Guerard, Mulberry, Fla.

1,255,901. SHUTTER - ACTUATING DEVICE. Paul J. Marks, Rochester, N. Y.


1,254,645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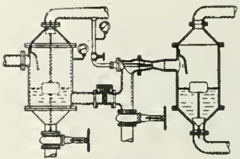
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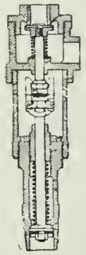
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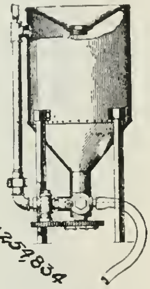
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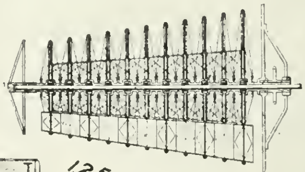
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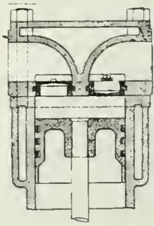
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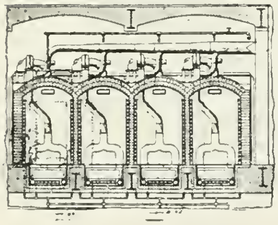

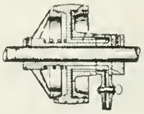
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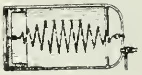
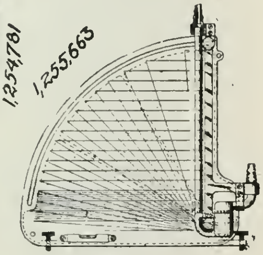

1,254,921


1,255,663

Pneumatic Patents January 29.

1,255,317. AIR-CONTROLLING MECHANISM FOR GLASS-BLOWING MACHINES. August Kadow, Toledo, Ohio.

1,255,327. AIR-CUSHION. George B. Maegly, Kansas City, Mo.

1,255,341. PNEUMATIC PUMP. Justin E. Russell, Chicago, Ill.

1,255,449. CRUDE-OIL ATOMIZER AND AIR-MIXER. Duncan C. McCaig, Vancouver, British Columbia, Canada.

1,255,518. BAROMETRIC CONDENSER. Raymond N. Ehrhart, Edgewood, Pa.

1,255,533. AIR-MODIFIER. Stephin J. Heinrich, Newton Highlands, Mass.

1,255,538. AUTOMATIC PRESSURE - REGULATING VALVE. John C. Kitton, Chicago, Ill.

1,255,574. PRESSURE-RELEASE. Rollin L. Bacher, Cleveland, Ohio.

1,255,592. CENTRIFUGAL OIL-BURNER. Milton A. Fesler, San Francisco, Cal.

1,255,632. AUTOMOBILE AIR-COMPRESSOR. Loreto Poccia, Mamaroneck, N. Y.

1,255,662. SUCTION-CLEANER. Joseph L. Sullivan, Cleveland, Ohio.

1,255,694. AIR-COMPRESSOR. Alvin R. Berck and Fred Tjaden, Hastings, Nebr.

1,255,787. FLUID SHOCK-ABSORBER. Francis V. Phillips, Orlando, Fla.

1,255,949. PNEUMATIC CONVEYER. Theodore G. Thormodson, Hanska, Minn.

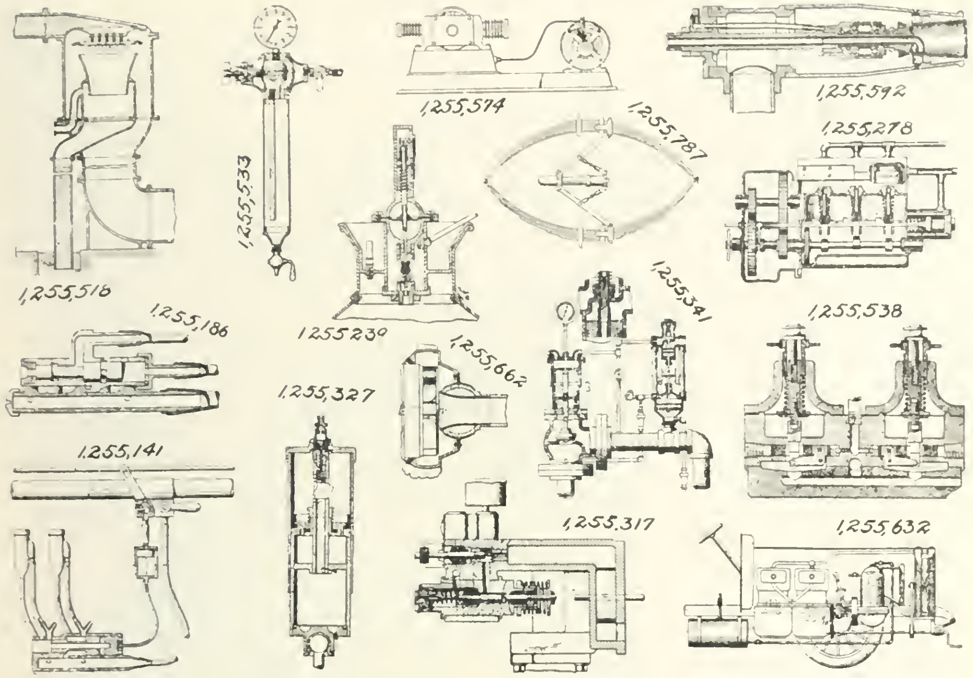
1,255,958. CAR-DOOR-OPERATING DEVICE. Walter V. Turner, Wilkinsburg, and William M. Cady, Edgewood, Pa.

1,255,972. PUMP AND PUMPING SYSTEM. Burton S. Aikman, Milwaukee, Wis.

1. In a pump, the combination of a diaphragm, a cylinder head member having a chamber on one side of the diaphragm, said head having a passageway communicating with the chamber, a compressed air inlet port opening into said passageway, an exhaust port opening into said passageway, a valve body adapted to obstruct said ports one at a time, the exhaust port having a substantially larger area than the admission port to produce a seating pressure upon the valve and means for shifting the valve from one port to the other.

1,256,017. APPARATUS FOR TREATING FLOUR. George J. Hicks, Saginaw, Mich.

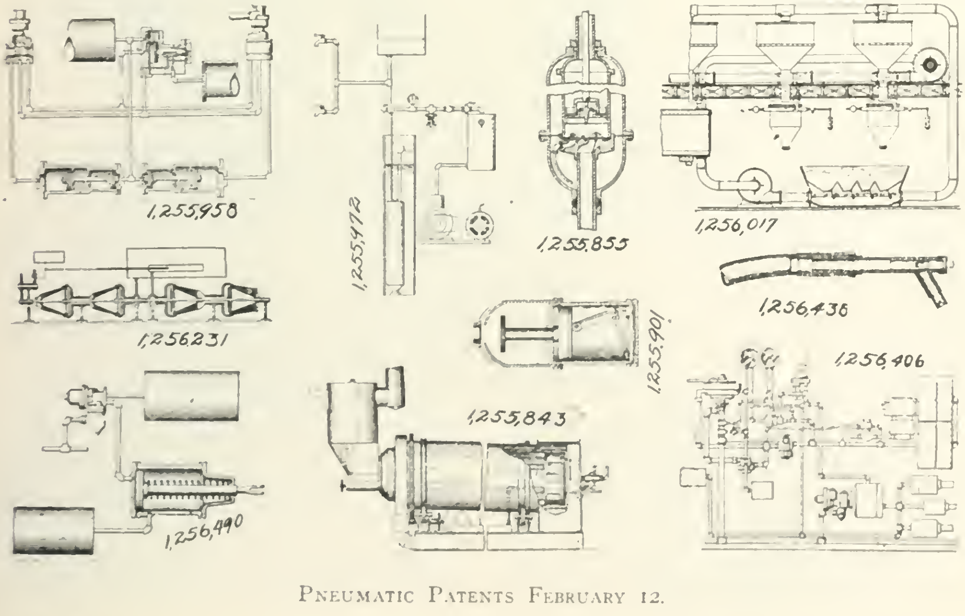
1. In an apparatus for treating flour, the combination with a bottom-discharge storage bin having a plurality of separate discharge outlets provided with closers, of an air tank, means for holding open all of said closers, and a blower for forcing air from said tank through flour flowing from the discharge of said bin.



PNEUMATIC PATENTS FEBRUARY 5.

1,256,231. METHOD OF IMPARTING, CONVERTING AND UTILIZING ENERGY IN CONNECTION WITH A COMPRESSIBLE FLUID MEDIUM AND APPARATUS FOR EMPLOYING SAID METHOD. Robert H. Hough, Philadelphia, Pa.

1. The method of converting kinetic energy of the mass velocity of a moving stream of an adiabetically expanding gas, and potential energy thereof into the kinetic energy of a rotatable turbo-member; which consists in permitting the progressive adiabetic expansion of the moving gas in skin frictional contact with the surface of said member; progressively conduct-



PNEUMATIC PATENTS FEBRUARY 12.

ing the moving stream in a delimited path of said contact, from a region of rotation of said member having relatively high linear velocity, to a region having lower linear velocity; and progressively increasing the cross sectional area of the stream, in its passage from the former region to the latter one, in substantial correspondence with the said progressive adiabetic expansion and said reduction of velocity.

1,256,406. AIR-BRAKE SYSTEM. Willis C. Webster, Dubois, Pa.

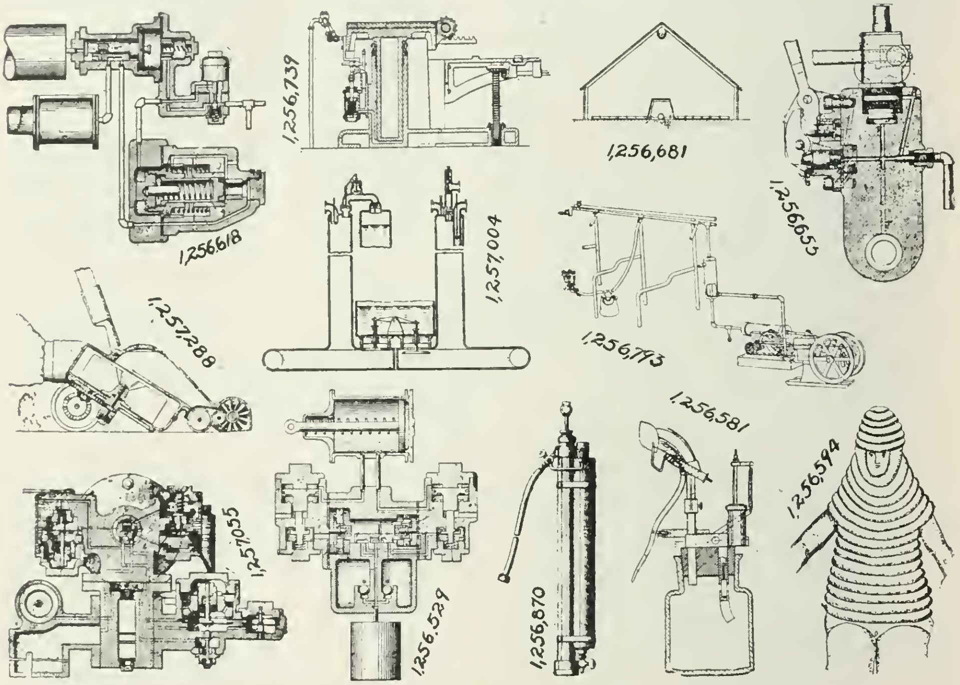
1,256,407. ENGINEER'S VALVE AND PRESSURE-CONTROLLING MECHANISM FOR AIR-BRAKES. Willis C. Webster, Dubois, Pa.

garment, comprising a trunk portion and a head portion, both of these portions being surrounded by inflatable tubing arranged in coils surrounding the trunk and head of the wearer, but free of engagement with the arms and legs of the wearer.

1,256,610. VACUUM FUEL-FEEDING SYSTEM FOR GASOLENE-ENGINES. Harold C. Suckert, New York, N. Y.

1,256,617-8. FLUID-PRESSURE BRAKE DEVICE. Walter V. Turner, Wilkinsburg, Pa.

1,256,655. COMPRESSOR INDICATING AND RECORDING DEVICE. John Rowland Brown, Mansfield, Ohio.



PNEUMATIC PATENTS FEBRUARY 19.

1,256,438. VACUUM COTTON-PICKING MACHINE. Bailey E. Chaney, Corpus Christi, Texas.

1,256,468. AIR-CONTROL GOVERNOR. Robert A. Gally, Cincinnati, Ohio.

1,256,490. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

FEBRUARY 19

1,256,529. BRAKE - CYLINDER - PRESSURE REGULATOR. Patrick H. Donovan, Edgewood, Pa.

1,256,581. INSTRUMENT FOR APPLYING LIQUID FINISH TO SHOES. Henri Marois, Lewiston, Me.

1. In a device of the character described, a liquid container, a feed pipe entering the container, a brush in said pipe, a guide adjacent said brush adapted to be moved manually in contact with some part of the work, a valve in said pipe, means for operating said valve and an air pump operable by the valve operating means for supplying air under pressure to said container.

1,256,594. SAFETY-SUIT FOR AVIATORS. Augusto Rodal, Habana, Cuba.

1. A sleeveless and trouserless sweater-like

1,256,681. PNEUMATIC METHOD OF VENTILATING COTTON-SEED. Alfred W. French, Piqua, Ohio.

1. The herein described method of treating cotton seed, consisting in supplying a volume of air at multiple points at the base of a pile of cotton seed of substantial horizontal area to cause said air to distribute and pass laterally and upwardly through the mass of seed to prevent the seed from heating and to cool any seed which may have become heated.

1,256,739. MOLDING-MACHINE. Chester H. Steele, Quaker City, and Frank H. Scattergood, Georgetown, Ohio.

1,256,793. MILKING APPARATUS. Samuel B. Harner, near Xenia, Ohio.

1,256,870. COMBINED PUMP AND FIRE-EXTINGUISHER. George D. Buck, St. Louis, Mo.

1,256,979-80. APPARATUS FOR THE MANUFACTURE OF BLOWN-GLASS ARTICLES. Benjamin Day Chamberlin, Rochester, N. Y.

1,257,004. METHOD OF COMPRESSING ELASTIC FLUID. Herbert Alfred Humphrey, Westminster, England.

1,257,055. TRIPLE VALVE FOR AIR-BRAKES. Willis C. Webster, Dubois, Pa.

1,257,288. SUCTION-CLEANER. James B. Kirby, Cleveland, Ohio.

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EVERYTHING PNEUMATIC

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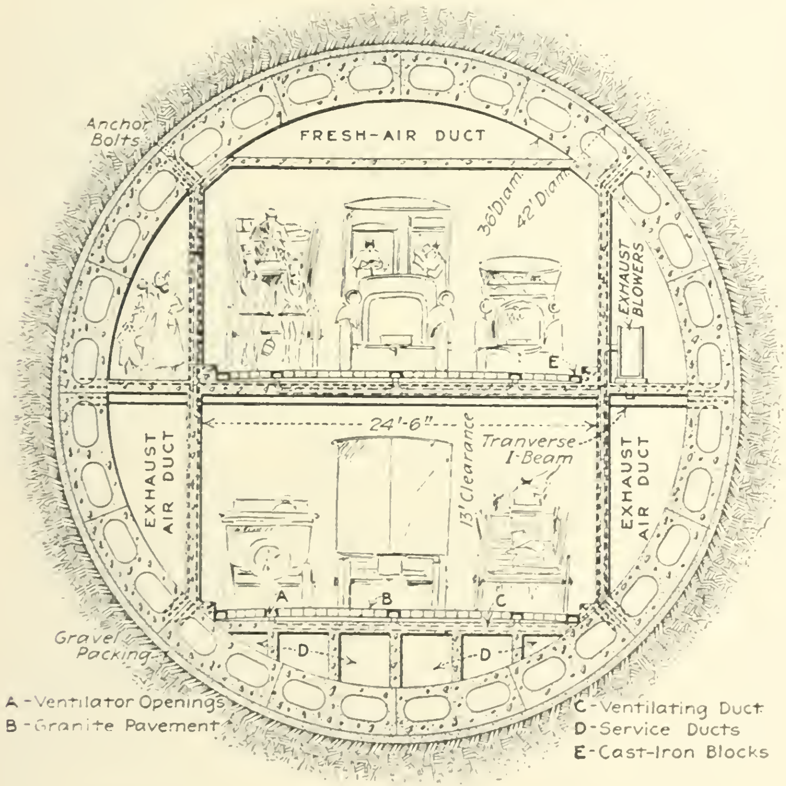

SECTION OF PROPOSED HIGHWAY TUNNEL UNDER THE HUDSON

NOVEL MULTIPLE-AIR-CHAMBER SHIELD FOR LARGE TUNNELS

By John F. O'Rourke*

The recent joint action of the Bridge and Tunnel Commissioners of New York and New Jersey, adopting the project recommended by their consulting engineer, Gen. Geo. W. Goethals, for a shield-driven highway tunnel of 42 ft. diameter across the Hudson River at New York City, involves the employment of a shield nearly twice the diameter of any heretofore used. In connection with a proposal to construct this tunnel for the sum of $12,000,000, the writer has designed a shield of radically new type. Application has been made for a patent on this shield construction.

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*President and Chief Engineer, O'Rourke Engineering Construction Company, New York. Article reprinted from Engineering News-Record, March 21, 1918.

The shield has multiple air chambers in its forward part, each ending 3 ft. in front of the chamber immediately above it, thus enabling the excavation to be done in separate vertical faces, the escaping compressed air from each chamber entering the ground forward of the excavation in the chambers above. Means are also provided to close the space between the tail of the shield and the tunnel lining.

HOW THE AIR ESCAPES

In considering the problem of a multiple-air-chamber shield and the behavior of the compressed air after its escape into the ground from its various levels, it is well to give attention to the manner in which escaping compressed air from pneumatic caissons makes its way through the ground to the surface. In the sinking of caisson foundations for river piers and large buildings, it has been found that the escaping air is dispersed for a considerable distance from the caissons before reaching the surface. While the greater part of the air ascends directly upward within narrow limits, in some cases of caissons for buildings it has been found escaping into cellars as much as 300 or 400 ft. distant. Experience has shown that where two caissons are being sunk in close proximity to each other the escaping air in the ground from the lower air chamber where the pressure is much higher caused no increase of pressure in the upper air chamber, showing that as the compressed air ascends it expands in proportion as the pressure is reduced in the groundwater. This is self-evident and needs no extended statement.

It is this principle of the reduction of pressure in escaping compressed air as it ascends through the ground that is at the bottom of the new plan for having superimposed air chambers in the forward part of a tunnel shield, in each of which an air pressure would be maintained suitable to the pressure in the groundwater at its front.

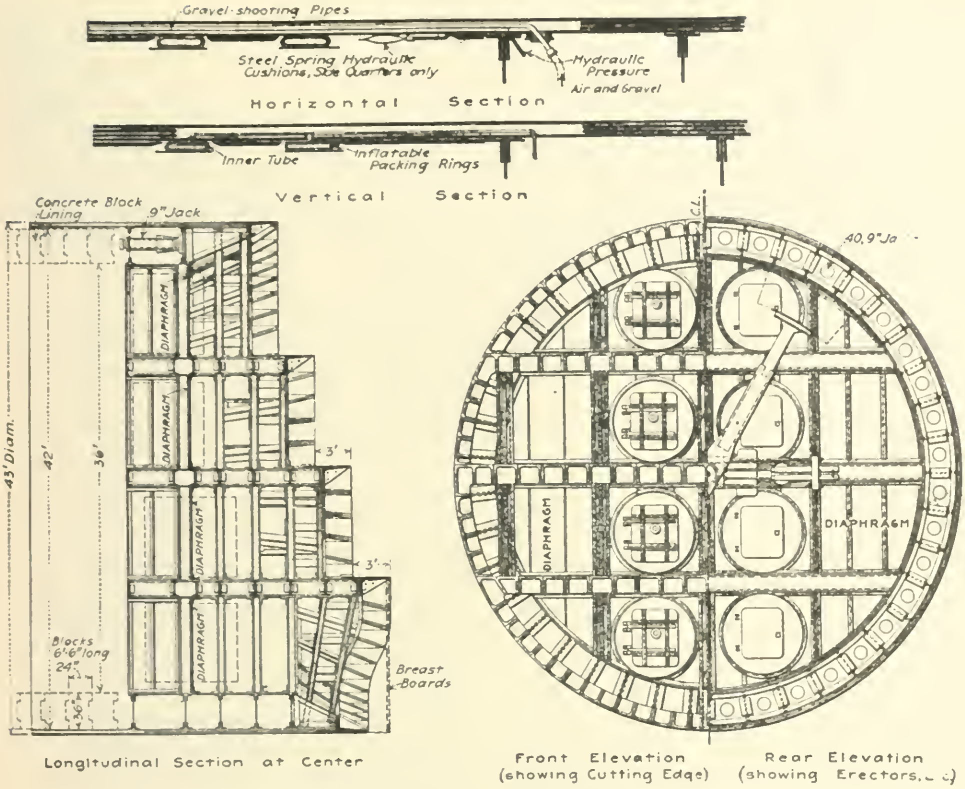
FACE STEPPED BACK FROM LOWEST CHAMBER

The shields heretofore used in the construction of tunnels have been designed for doing the excavation at the front of the shield from the top downward in one vertical plane, the face of which is held in place with breastboards when the material at the face will not stand up by itself; bracing and jacks hold the breastboards in place as the excavation proceeds and while the shield is being shoved forward. The shields have been divided horizontally into two or more levels when the diameter was too large for the excavation operations to be conveniently worked from the bottom, and the platforms forming the levels usually had extensible fronts operated by jacks which were shoved forward, following the excavation, to hold the breastboards during excavation and shove. The same object is attained in the new shield by numerous breast jacks arranged above one another in tiers.

In the longitudinal section of the multiple-air-chamber shield shown here, the roof and top cutting edge of the bottom air chamber extend outward about 3 ft. beyond the roof and top cutting edge of the air chamber above; the cutting edge of the second chamber has a like projection beyond that of the chamber above it, and the other chambers above recede successively in like manner.

The excavation for each shove starts simultaneously in all the air chambers, in line with the cutting edges, so the faces of the excavation are in the same planes as the cutting edges. The floors of each chamber, except the bottom one, extend forward of the excavation the length of the step. When the shove is made, the floor of each chamber slips forward so that after the shove it is the length of the shove in addition to the length of the step in front of the face of the excavation. It is to be remembered that, in the chamber below, the top face of the excavation is at the cutting edge of the floor of the chamber above. This enables the men in each chamber to look after the ground into which the cutting edge is being shoved, to pull down the top breastboards and bring in small boulders as the cutting edge reaches them, or, in case a large boulder is encountered that might injure the cutting edge, stop the shove until it is either brought in or blasted. At the end of the shove the cutting edges are out at the position where excavation is started for the next shove.

The bottom air chamber has the bottom of the shield for its floor, as in all shields, and the usual practice of keeping the bottom cutting edge a full shove back from the face of the excavation is followed, as this leaves the ground at the bottom exposed and the presence of rock or boulders is known and taken care of before the shove. In this way all of the shoving is done under the same conditions of observation



Horizontal Section

Vertical Section

Longitudinal Section at Center

Front Elevation (showing Cutting Edge)

Rear Elevation (showing Erectors, etc.)

DETAILS OF SHIELD CONSTRUCTION

and control in the multiple-air-chamber shield as in the ordinary shield whose only cutting edge is in the circumference.

At the forward end of the jack circle are located diaphragms which form the inner wall of the air chambers and contain air locks which, together with the air-tight floors and sides, make each forward level an independent and workable air chamber with an open front. Each chamber is worked with its own excavating force. This greatly expedites the excavation, which in the case of four levels has four times as many men and requires only one-fourth of the time that would be taken in a shield of one level excavated from the top downward with one-fourth the number of men at work in the shield.

In water-bearing ground each air chamber would be filled with compressed air of suitable pressure for the water in the ground in front of it near the floor, and the unbalanced pressure in each chamber would therefore be approximately that of the height of the air chamber, which under the ordinary practice, would require a cover 1¼ times the height of the chamber. Under this rule the ground in front of the tunnel is sufficient cover for all but the top air chamber, which would require a cover above the top of the shield of 1¼ times the height of that chamber. In the case of an ordinary shield of the diameter under consideration here, the height of cover that would be required above it to retain the unbalanced air pressure would exceed 50 ft., while the multiple-air-chamber shield would require a cover on top of only 13½ feet.

That compressed air cannot enter an upper air chamber from a lower one where the pressure is higher is evident from what has already been stated in regard to the behavior of compressed air that has escaped into the ground from pneumatic caissons. In the case of the tunnel shield, the air escapes into the ground some distance forward of the air chambers above, where it immediately expands to the pressure of the groundwater through which it is ascending. As it passes in front of each successive air chamber it only has the pressure in the ground at that level, to meet which each chamber has already an equal or greater air pressure, so that there is no possibility of the air escaping from any chamber entering any upper chamber at a pressure higher than that already in that chamber. There is therefore no question of the practicability of maintaining independent air pressures within superimposed air chambers at the forward part of any shield when they project beyond one another in steps which allow the air to expand in the ground outside.

AIR LEAKAGE AT TAIL OF SHIELD SERIOUS IN LARGE TUNNEL

The next question that arises is in regard to the air pressure within the tunnel itself. This is a matter of great importance, as all the accidents that have heretofore occurred under rivers in which the earth at the front of the shield was blown away happened because of the air escaping at the tail of the shield carrying away the cover sufficient to permit the blowout at the front. Even with multiple air chambers at the front, the unbalanced air pressure in the tunnel, still equal to the total diameter, requires a radical change from the present practice in regard to closing the space between the tunnel lining and the tail of the shield. This is done in the new shield by packing. Three rings of steel plates, each about 1 in. thick, are riveted and calked to the tail and spaced apart sufficiently to form recesses; into these are set two inflatable packing rings in sections and mounted on thin metal plates. The bottom of the inflatable packing ring consists of strips of rubber, leather or the like, which project forward in the case of the tube nearest the end of the lining and backward in the case of the tube nearest the tail. These tubes would be connected to high-pressure air pipes through spaces in the skin of the shield, entering the latter inside the jack circle. The tubes would be maintained under pressure except when the shield was being shoved, during which time the pressure would be reduced to lower the friction between the tubes and the tunnel lining. The projecting lip in the case of the one nearest the end of the lining would be forced against the lining by the air pressure like the familiar flap valve, so that when the pressure in the tube was reduced there would still be a pressure contact between the lip and the lining to obstruct the escape of the compressed air. In like manner the projection from the tube near the end of the tail would be forced against the lining by pressure of water seeking to enter, so while the pressure in that tube was reduced the contact between lip and tunnel lining would prevent entrance of water.

Suitable air pressure, or even free air, in the forward parts of the shield or in the tunnel itself, can be maintained by reason of the air-tight and water-tight connection between lining and shield and by the facility with which the reversible doors of the air locks can be operated with the greater pressure either in front or behind the chamber. Thus a tunnel in part above water or ground can be driven, having compressed air in the shield chambers below water and in the tunnel itself.

The shield construction shown makes practicable much larger tunnels than heretofore. The importance of this lies in the fact that tunnels of larger capacity can be built at less cost and occupy less space than the several smaller tunnels that would be required to furnish the same capacity. The larger tunnel is obviously more desirable, particularly in highway tunnels, where the capacity increases faster than the number of lines of traffic in the same direction on the same level.

The forward inflatable tube is at the centre of the last ring set at the end of the shove and supports that ring in circular form. As the clearance between the tail of the shield and the tunnel lining increases from nothing at the bottom to 2 in. at the top, the varying space between the lining and the shield has to be maintained in preserving in circular form the next ring to be erected. It is proposed to accomplish this by having a metal tube properly recessed into the tail on each side of the shield, occupying the middle quadrants and maintained by water pressure. These steel tubes would be in comparatively short sections and would be distended to correspond with the curve of the lining, thereby permitting of the ready erection of the lining in exact form and of holding it in place until the next shove brings the forward inflatable ring around it.

VOID BACK OF SHIELD TO BE FILLED BY GRAVEL SHOOTING

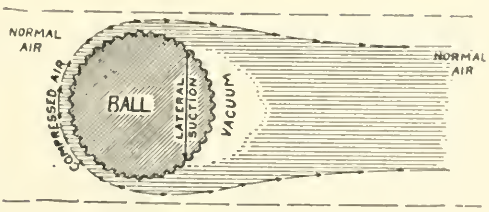
The drawings of the shield show spaces in the skin between the jack circle and the end of the tail in which are rubber hose. Through these, gravel is blown to fill the space in the ground at the tail of the shield at the time the shield is being shoved forward. Experience has already shown that this gravel packs the space in the ground around the tunnel lining with great completeness and solidity. The gravel is ejected at a high velocity and the impact upon itself breaks the gravel into small particles with enough of its own dust to convert the broken gravel into a very dense embryo sandstone. This material, acquiring considerable hardness at once, holds the tunnel lining in place as set and maintains the surrounding ground in place without settlement or disturbance and in immediate connection with the lining, so that the ground and the lining sustain each other at once without movement of either. While the Pennsylvania R. R. tunnels were being driven across the Hudson River it was found necessary to use both braces and tie-rods to maintain the circular form of the cast-iron lining and these had to be retained in place for almost a year after the tunnel had been built, at the end of which time it was found that the ground had settled tightly around the lining with great uniformity of pressure so that the cast-iron tunnels retained their circular form unaided when the braces and tie-rods were removed to place the concrete lining.

This new method of filling with gravel the space in the ground between the lining and the walls of the excavation before either has had a chance to settle preserves the equilibrium of the ground undisturbed, and the same uniformity of pressures is obtained at once that in the case of unsupported ground required a year of settling to obtain by the restoration to the ground of its former equilibrium.

THE COMPRESSED AIR TAIL OF THE GOLF BALL

By P. A. Vaile

One frequently hears golfers and others asking the reason for the marking of the cover of the golf ball. The answer always is that the marking is necessary in order to make the ball fly straight. In other words the ball will not hold its flight unless it has some kind of a pattern on its cover; this has been proved beyond any possibility of argument; the smooth ball has a most erratic flight, that, in fact, makes it useless to a golfer.



These phenomena have not, however, been explained by the scientists. It is a subject of much interest and of great practical importance to golfers so it is quite worthy of consideration and elucidation.

Nothing flies well without a tail. This might almost be laid down as a fundamental axiom in general aviation. As boys we have all seen the futile efforts of a sparrow to guide himself when minus his tail-feathers. A kite is useless without a tail. Where would the arrow go without its feather? The old round rifle bullet was a poor thing compared with the modern bullet that has got its "tail" in its *length and spin,* and an airplane without a tail would cut a sorry figure.

As it is with all of these so it is with the golf ball. It cannot fly well without a tail. It, in effect, has a tail, but it is invisible. That accounts for much of the mystery of the flight of the golf ball.

The golf ball leaves the face of the driver in a well hit stroke at a very great speed. It follows naturally that in front of the ball there is a cushion of compressed air. It follows just as naturally that immediately behind the ball there is something approximating to a vacuum. These are both clearly shown in the diagram. It will be clear that, from the front point of extreme compression to that point where the compressed air regains its normal density, there is a disturbance in the atmosphere in the form of a tube of compressed air, of varying density and containing a small vacuum.

As the ball travels forward it makes and, in a constantly decreasing degree, maintains this tube of compressed air. As this compressed air flows over the ball, if we may inversely express it in this manner, it spreads and runs between the excrescences on the ball.

The indentations thus get a grip, or take hold, of the air so that the ball is steadied in a remarkable degree during its flight and, although this is a point that has never even been raised, the suctional action in lateral rear of the ball, probably also gets greater control on account of the marking of the ball.

It will thus be seen that, in effect, the golf ball has a "tail" of compressed air wherever it flies; that this tail is of varying degrees of density from the point of utmost compression in front of the ball until it regains normal density behind the ball, and that, on account of the lateral suctional action of the "tail" its influence persists until the point of normal density is reached.

We have now to consider the phenomenon of the erratic flight of the smooth ball. This has puzzled even a scientist so eminent as Prof. J. J. Thompson, Cavendish Professor of Physics at Cambridge University, England, and winner of the Noble Prize for Physics. Professor Thomson has admitted that he is unable to explain it, and, indeed, it is not easy to do so, but the explanation of the flight of the rough ball may help us in the consideration of that of the smooth sphere that is never used in practical golf.

The smooth ball cannot be relied on in any way. It ducks and soars and darts about sometimes almost as erratically as a butterfly. It would seem that the reason for this is, primarily, that its lack of grip prevents its "holding into its line." In other words the ball has a better chance of "slipping" its cushion of compressed air.

This probably is aided considerably by the defective center of gravity of the ball, a most common fault in most golf balls and a grave defect.

If the center of gravity of the ball is defective one side will lag more than the other and this will be seized on instantly by the compressed air to force the ball out of line. If the ball encounters, as it of course very frequently does, strata of air of varying density and also air pockets, these vagaries will be exaggerated; for the stream of compressed air is distributed thinly and, comparatively speaking, evenly over the surface of the smooth ball. It is then easier to break through than if the ball were, if we may so express it, in the grip of the "fingers" of compressed air that clutch the marked ball.

A consideration of these phenomena forces one to the conclusion that in the near future the marking of the golf ball by determinate indentations as in the ordinary "dimple" or "pit" markings will become obsolete. The bramble or pimple marking is now, if not actually obsolete, at least obsolescent, and in the opinion of many good judges it will soon be the same with all determinate markings, for they interfere with the "stream line" of compressed air and have no advantage whatever over the old marking by indeterminate grooves or sunken lines that ran right round the ball and allowed the compressed air to escape without unnecessary friction.—*Scientific American.*

VALUE OF COMPRESSED AIR IN ELECTRIC CENTRAL STATION CONSTRUCTION

For many applications pneumatic tools will now be found most economical in various forms of construction, for replacing manual labor and where costs and time have to be reduced. This applies to work indoors as well as outdoors.

Indoors, there are often concrete walls and floors, iron slabs, steel girders and re-enforcing to be cut through in running conduit, and so on, where considerable heavy labor is often required. The pneumatic drill and hammer for work of this kind will save time, and also money. So, too, outdoors, for cutting out sections of asphalt, opening up concrete sections of the road and cement slabs on the sidewalks, the compressed air drill may be used to advantage. It is particularly beneficial in cases where an important section of road has to be opened up during the night and be relaid before traffic begins next day.

Street railway companies and municipal contractors have employed pneumatic tools for various purposes quite largely. On the other hand, central station companies have not adopted it as largely as they might for their station construction and outside work. However, recently one central station company in Iowa used an air drill when laying conduit with very pleasing results. Instead of having to remove whole slabs of cement sidewalk, as had been necessary in the past, the air drill was used to cut a strip about a foot in width, thereby saving much time and reducing the expense. When using hand cutting the cost had been 40 cents per foot, but by using two drills and an electrical portable air compressor the cost was reduced to 18 cents per foot, the job also being prosecuted much more rapidly.—*Electrical Review.*

PNEUMATIC COAL PUNCHER

COMPRESSED AIR IN THE COAL MINE

By Charles A. Hirschberg

The mining of coal has developed to a point where it is quite generally conceded that the advantages of operation are all on the side of machine mining as compared with hand work. Machine mining quickens production, increases the capacity-to-produce of each man unit, making it possible either to expand coal mining operations or to release miners for other portions of the work as occasion requires. The labor problem has affected the coal mining industry the same as every other industry and the present acute shortage makes the superiority of machine mining especially pronounced.

As is the case with every other industry, there are several classes of machinery from which the coal operator can choose, and the problem, therefore, becomes one of selecting that type and make of equipment which will produce coal in quantity with greatest economy and efficiency.

In the early days of coal mining the miner with pick, shovel and hand auger played a vital part. Then followed the introduction of compressed air-operated machines and new methods of mining which were a decided improvement over hand work.

Latterly, as the application of electric power spread throughout every industry, mining machines driven by motor were introduced, partially replacing compressed air equipment for certain classes of work.

Of late the methods of coal mine operation have undergone still further changes, as a result of which compressed air has resumed an important place for certain phases of the work. There is no intention to deny electricity any of its just dues, for it is performing admirably in coal mining. Nevertheless current practice shows three distinct classifications of coal mines, namely; the compressed air operated mine, the electrically operated mine and the mine which utilizes a combination of the two. In the discussion which follows, no attempt will be made to tell the story of the electrically operated mine, but will be confined to a discussion of the methods and advantages of employing compressed air, either exclusively or in combination with electricity.

Coal mining logically divides itself into two divisions of work; development and production. The chart herewith shows the range of work and the application of air tools.

DEVELOPMENT WORK

The problems involved in sinking shafts and driving development tunnels do not differ from those of contract or metal mine work of similar nature. The same methods are pur-

DEVELOPMENT	Shaft Sinking	Unmounted Rock Drills		
	Tunnel Driving	Mounted Rock Drills Unmounted Rock Drills		
	Entry Driving	Unmounted Rock Drills		
	Drainage	Ditching Sump Digging	Unmounted Rock Drills	
	Haulage Installation	Track Ballasting	Pneumatic Tampers	
		Hanger Hole Drilling	Unmounted Rock Drills	
	Stripping	Unmounted Rock Drills		
PRODUCTION	Thick Seam Mining	Undercutting Overcutting	Flat Seams Pitching Seams	Air Punchers Air Chain Cutters Mounted Radial Punchers
		Shearing	Mounted Radial Punchers	
		Shot Hole Boring	Air Auger Drills	
	Thin Seam Mining	Undercutting	Mounted Radial Punchers	
		Shot Hole Boring	Air Auger Drills	
	Open Pit Mining	Unmounted Rock Drills or Air Augers		
	Haulage	Air Locomotives Air Hoists		

COAL MINING OPERATIONS AND MECHANICAL EQUIPMENT

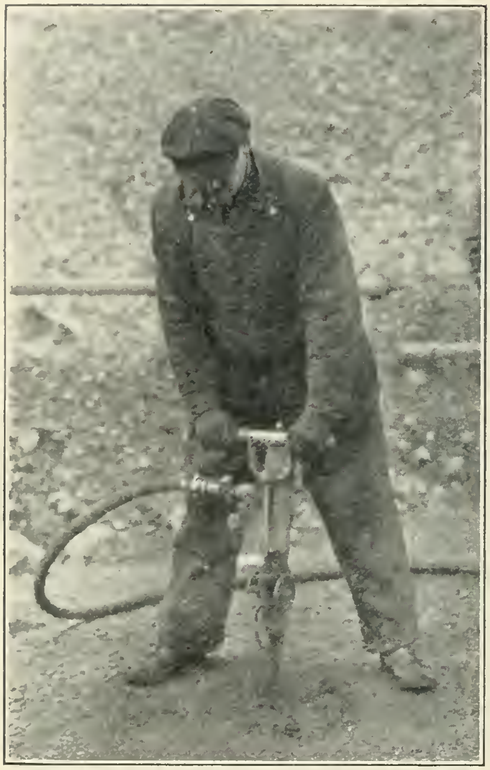


FIG. 1. JACKHAMER DRILLING COAL BED

sued and the same classes of machines used. Everyone will concede that for this class of work—rock drilling and excavation—compressed air is unrivaled. The work is of rough character and none but the most rugged machinery is capable of standing up to the work.

Fig. 1 shows the unmounted type of drill employed for down-hole drilling, such as shaft sinking and bench work. It has, on occasion, been mounted for light heading work.

An estimate of the capacity of the mounted drill may be gained from a performance record on a development tunnel at Shenandoah, Pa., where 513 feet of 12x7½-foot tunnel, carrying a 4x2-foot drainage ditch, was driven in 28 days, working three 8-hour shifts per day.

At one of the D., L. & W. mines, where a shaft sinking job was in progress, an unmounted drill, in this case a "Jackhamer," was observed to have put in a total of 4,760 feet of drill hole in 17 days' working.

At a Tennessee mine a 7x14-foot shaft was sunk 24½ feet in six days, working two 9-hour shifts per day. Six drills were employed, drilling a round of thirty-six 5-foot holes.

The drill shown in Fig. 1 has also found a wide application in driving entries, almost entirely supplanting the mounted rock drill for this purpose. It has been found more suitable due to its lightness, its ready movability and its ability to work in restricted quarters. It is also employed to a considerable extent in track work, leveling the track bed, drilling trolley hanger poles and trimming roofs.

There comes from Kentucky an interesting comparison of the time required for drilling trolley hanger holes. Two men with hammer and steel were taking a whole day to drill 9 or 10 holes from 4 to 6 inches deep when by the use of a "Jackhamer" it was found that one man could do an equal amount of work in from 10 to 15 minutes.

TRACK WORK

In the Lake Superior region among the iron and copper mines, the problem of track installation and maintenance has been met by the adaption of pneumatic track equipment. They have profited by the experience of the steam railroads. The use of the track tamper in track work has resulted in a considerable saving in labor and cost in track maintenance,

FIG. 2. SHAFT SINKING WITH JACKHAMER

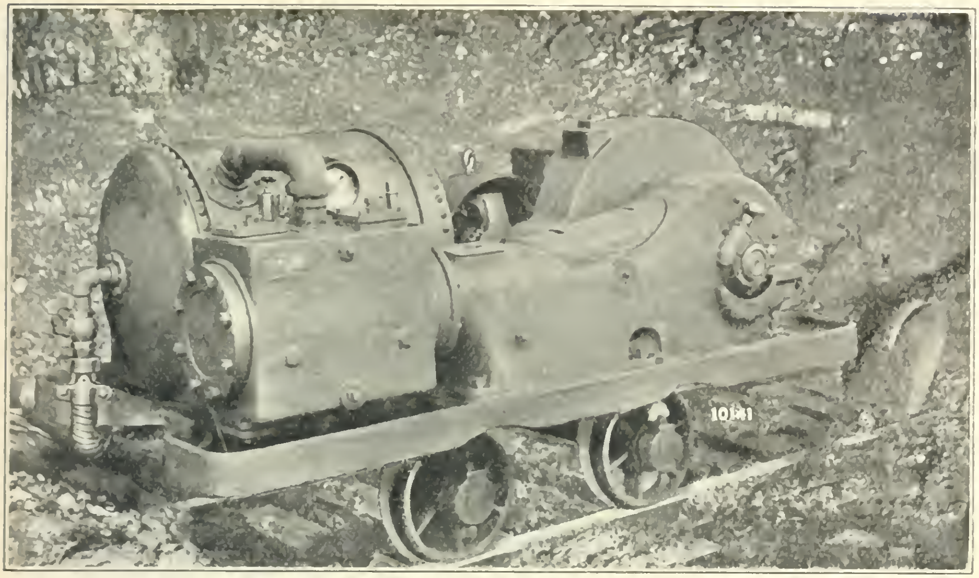


FIG. 3. A MINE CAR COMPRESSOR

and inasmuch as the track problem in coal mines is not dissimilar to other mine track work, the pneumatic tamper should prove of service to the coal operator.

Having the pneumatic tamper, there are other uses to which the coal mine can adapt it. During the recent cold spell these tools were employed on the docks and coal dumps at shipping points for breaking up the frozen masses of coal in hopper-bottom cars for reloading into barges, etc. For this kind of work a pointed pick was used in place of the usual tamping bar.

THE CAR-MOUNTED COMPRESSOR

For mining and handling coal underground, in electrified mines which are not piped with air, compressed air equipment has been made available by the introduction of portable mine car mounted, small compressor units. The mine car compressor is comparatively a recent development in the application of compressed air to modern coal mine operation, and bids fair to grow in favor as its advantages are better appreciated. An outfit of this kind is capable of rendering remarkably consistent service with but little expert attendance, due primarily to its dirtproof construction, self-lubrication and automatic control. Ordinarily the compressor is operated close enough to the face to obviate the need for even semi-permanent piping—a hose connects it to the tools. While compressor units of this kind have undoubted advantages in an already electrically equipped mine, it would not be advisable under ordinary circumstances, to install electricity for the purpose of operating them. Greater economy would undoubtedly be obtained by the erection of an above-ground compressor plant, with a modern Corliss or piston-valve steam-driven machine, and boiler equipment to utilize coal as fuel.

These mine car compressors are usually employed in operating pneumatic coal picks and pneumatic augers for boring shot holes, breaking down coal, and to some extent in picking out dirt and slate bands. In general, the tool is of the "Jackhamer" type and is used as a hand drill, being held and guided by the miner. Originally introduced into coal mines for shaft work and rock drilling in entries, tunnels, etc., these little machines have since developed applications which connect them more intimately with the actual production of coal, as already mentioned above. In drilling rock they require a hollow hexagon drill steel, but for work in coal it is usual to employ a twisted cruciform steel of the coal-auger type.

The amount and varied character of work which they are capable of doing is best exemplified by brief citations of actual work done.

At one West Virginia mine two "Jackhamers" (one in use 9½ months, the other three months previous to the time of writing) are reported to have driven 11,460 feet of narrow entry, 7,868 feet of entry 10 feet wide, 3,292 feet of 12-foot entry and 3,000 feet of 22-foot entry, slate on the whole work averaging about 6 feet in thickness. In addition, four overcasts of a total area of 331 square feet have been made, two waterways 50 feet long by 2½ feet square have been driven, a ditch 125 feet long, 18 inches wide and 3 feet deep has been dug, and a pump room 9x12x18 feet cut in solid rock.

drilling boulders and cap rock for blasting preparatory to shovel loading and further for drilling the coal bed.

The experience of a Texas mine in boring in a 30 to 40-inch seam of semi-bituminous coal is an excellent example of the comparative working speed of hand augers and a "Jackhamer" drill. By the former method four men using a post auger consumed five hours in drilling four 4-foot holes, while with the air drill two men did the work in about 25 minutes. At this mine the working space is very low and the men must kneel.

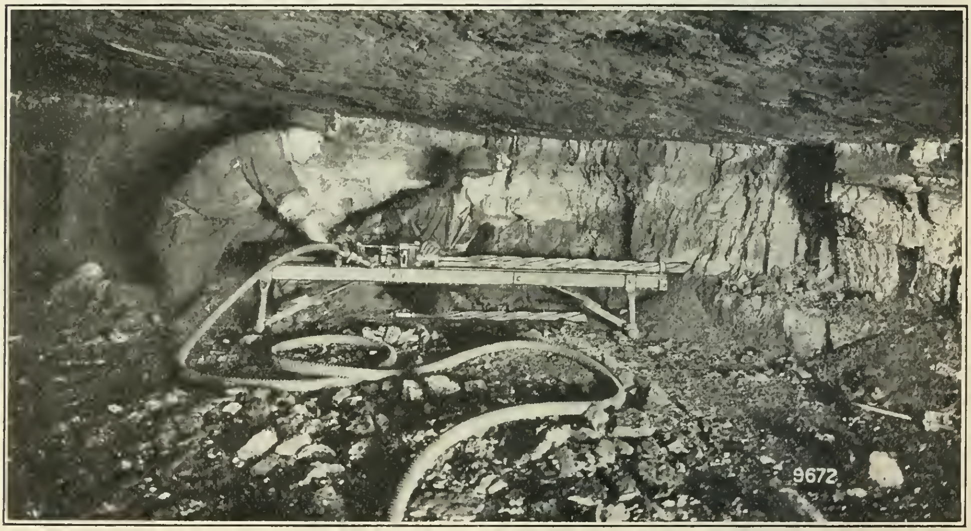


FIG. 4. BORING HOLE IN THIN SEAM WITH JACKHAMER

In a Kentucky mine these drills are spoken of as having proven "most useful" in drilling the fine grain, hard sandstone roof above the coal. Mention is also made of their use for "shooting sumps, taking bottom, and drilling hanger holes."

In a Washington mine two "Jackhamers" were recorded as having driven 2,000 feet of rock tunnel and 1,700 feet of gangway in coal, including the lifting of bottom rock, and were expected to shortly complete a second 3,000-foot rock tunnel.

In stripping operations, such as are being carried on in the Kansas and Illinois districts, drills of this type are extensively used either with a portable compressor or as an adjunct to the steam shovel and operating on steam direct from its boiler. The duty consists in

"Jackhamers" and the portable mine car compressors already described form a combination equipment that has won favorable comment in many mines for its ability to bore shot holes in coal most economically. The measure of their superiority over other methods is well exemplified by the fact that one single company has placed some 30 odd compressor units in its mines.

In the work mentioned in the foregoing paragraphs the drills were used without mountings, being held and guided by the workmen. There are, however, recently developed mountings whcih relieve the miner of considerable muscular effort and at the same time facilitate the work. For rock tunneling it is possible to equip a "Jackhamer" with a detachable feed-shell mounting which makes it then

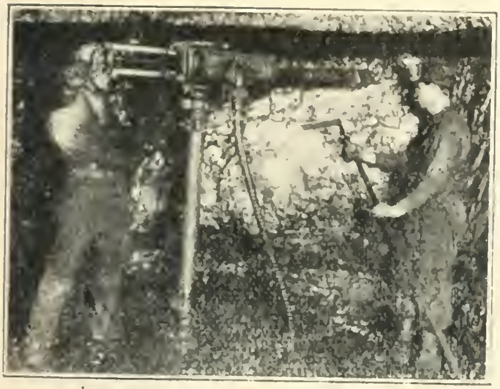


FIG. 5. OVERCUTTING WITH RADIALAXE

adaptable to use as a column mounted drill. This type of mounting has found wide favor among the metal mines and will undoubtedly be employed in future coal mine tunnel and rock drilling development work.

The second mounting (Fig. 4) accommodates the "Jackhamer" when fitted for boring coal, and was originated to meet the demand for a means of mining thin seam coal. The successful method is entirely one of boring and blasting, the slight extra expense for powder being more than absorbed in the time and labor saving as compared with other mining methods. In narrow workings of this kind a mounting, such as shown in Fig. 3, relieves the miner of the need for effort other than that of pushing the drill forward on the slide rails. The four legs are provided with extension pieces which permit adjustment of the mounting for drilling holes at any needed angle. In operating with this mounting the drill is clamped in a light cradle to give a bearing on the slide rails.

This type of mounting has proven of great assistance to operators in speeding up work, and it is expected that it will be adapted to work in high as well as narrow seams.

Compressed air-driven mining machines are inherently sturdy, simple, abuse-proof, and in consequence maintain their initial efficiency despite the handicap of unfavorable working conditions and unconsciously careless handling. It is perhaps for this reason that the employment of one of the earliest type of coal mining machines, namely, the coal puncher, still persists in a great many coal mines for the work of undercutting. Its one limitation is that it is only applicable in flat or slightly pitching seams, in which the angle of pitch does not exceed 25 deg.

THE RADIALAXE

For such work as undercutting and overcutting shearing in more sharply pitching and narrow seams the post machine similar to the Radialaxe (Figs. 5 and 6) has proven the only practical means of machine mining such coal formations. The machine is of the reciprocating puncher type, and is mounted on a short column equipped with means for swinging it in an arc in any plane from horizontal to vertical.

It has proven very successful in coal formations, regardless of thickness, for the work of cutting out bands of dirt, clay, etc. As instances of typical performance it is interesting to note the following: In one Canadian mine, the coal bed is 6 feet high and almost level. The rooms average about 20 feet wide, and these are undercut by Radialaxe machines to the full depth of 5 feet 6 inches, or 6 feet, and the coal blown down by the three-hole system. One hole is placed about the center of the room, about 4 feet from the floor of the mine, and is known as the plug hole. A hole is then drilled out of each corner of the room, about a foot from the side or rib, and a foot from the roof. The center or plug hole is blown first, then the two corner holes are blown together.

The output per machine will vary all the way from 5 to 10 rooms, depending on local conditions of roof, floor and the existence of sulphur balls, and on the ability of the op-

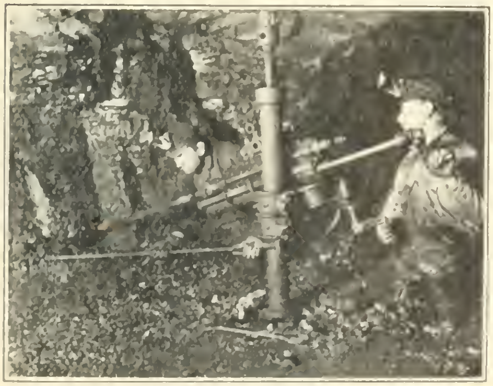


FIG. 6. SHEARING WITH RADIALAXE

erator. Down there, the coal is all cut by contract, the machine runner getting so much a ton and paying his own helper. It is rather difficult to get at the maximum capacity of the machines owing to this fact. That is to say, the machine runner makes anywhere from $8 to $15 per day clear of expenses, and when he has made what he considers enough for one day, he quits and goes home. If he has good luck and good air pressure, he may get his 10 rooms out in five or six hours, when he is free to go home.

In a test performance, one Radialaxe cut 84 rooms, 30 feet wide in 16 shifts.

At an Albama mine a 3-foot coal seam was undercut at a rate of 280 square feet in 4½ hours, including all moving time. On the basis of a ton per cubic yard this amounts to a production figure of 60 tons per nine-hour shift.

In Southern Illinois under high coal and in level veins the Radialaxe will undercut two 25-rooms to a depth of 6 feet, or will shear about four places 10x7 feet.

At another mine one man established a record of undercutting ten 20-foot rooms to a depth of 6 feet in an eight-hour shift. Coal in this seam pitches about 16 to 20 deg. and is 6 feet 4 inches in thickness.

A Radialaxe operator was timed at one of the Canadian mines and the following figures recorded: 21 minutes were required to make a 6-foot undercut 14 feet wide. The initial set-up of the machine required just five minutes.

In cutting out an 8 to 10-inch band of dirt in the center of the coal seam in a Tennessee mine 60 square feet of cut was accomplished in one hour and a half. The cut was made at the bottom of the band, removing all but 3 inches of the dirt, and as soon as the cut was made this remaining dirt fell in, leaving the coal practically clear.

COMPRESSED AIR LOCOMOTIVES

The same conditions which necessitate the use of air mining machinery make it expedient to utilize the compressed air locomotive for gathering and haulage work. In actual work done the compressed air locomotive compares favorably with other methods of haulage, in convenience, efficiency and economy. Its outstanding virtue is the entire absence of the fire hazard and that of danger from electric shock as well as the avoidance of creating disagreeable exhaust gases. The air locomotive is self-contained and after the laying of track there is no supplementary wiring or rail bonding to be done; a particular advantage when the trackage is at best only temporarily needed. The modern air locomotive uses air expansively, in two stages. Manufacturers of these machines state that except under unusual conditions the cost of power to operate is no greater than that required for electric types.

As an instance of the economy which obtains with air haulage as compared with horses, the following figures are quoted, taken from a paper by Raoul Green delivered before the Canadian Mining Institute, in 1916.

The observation was made in a mine working under the following conditions: seams pitching 25 deg. or more; pit cars containing two to three tons; rails weighing 30 to 40 pounds per yard; grades fluctuating but little from 0.46 to 1.00 per cent in favor of the loads; gangways roomy; tracks fairly well kept; curves few and slight.

	Compressed air	Horses
Labor	$0.046	$0.072
Supplies	0.017	0.022
Depreciation	0.015	0.015
Total cost per ton-mile..	$0.078	$0.109

In recent years an air-operated type of hoist has been developed, which is being used extensively for the work of hoisting and lowering timbers, hauling cars in gangways and up and down inclines; in general, replacing hand power for light work. This hoist can be attached to any convenient means of support, such as a column, bar, pipe, timber, etc.

The surface compressor plant which supplies air to underground mining equipment also furnishes power to such shop equipment as drill sharpening and grinding machines, pneumatic drills, wood borers and riveting hammers and the like.

The machine drill sharpener with its auxiliaries, the shank and bit punch for hollow steel, and the shank end grinder play an important part in maintaining the drilling equipment at a point of high efficiency. This is especially important in the case of rock drills, as the absolute perfection of each drill bit is a necessity if lost time is to be avoided in the work of rock cutting. Improperly sharpened or imperfect drill bits handicap the most powerful drill and cause steels to wear excessively and often to stick in the hole.

A machine drill sharpener at a Nevada mine, operated by one blacksmith and a helper, turned out an average of 84⅓ resharpened bits per hour over a two months' working period at a total cost of 1.709 cents per bit. This alone is conclusive evidence that hand drill sharpening by comparison is too costly to be permitted, under present conditions, at any mine.

In closing, it is well to note that compressed air is a safe power. There is an entire absence from danger of fire or possible gas explosion, and in time of danger from other sources it is capable of giving valuable assistance. Air pipes may be used as water carriers for flooding purposes in cases of fire, as messengers and food transmitters in case of cave-ins and as a means of ventilation. In this latter respect, it will be found that the exhaust from compressed air tools has a salutary effect upon the ventilation of the mine.—*The Coal Industry.*

A NEW GAS FOR WELDING AND CUTTING

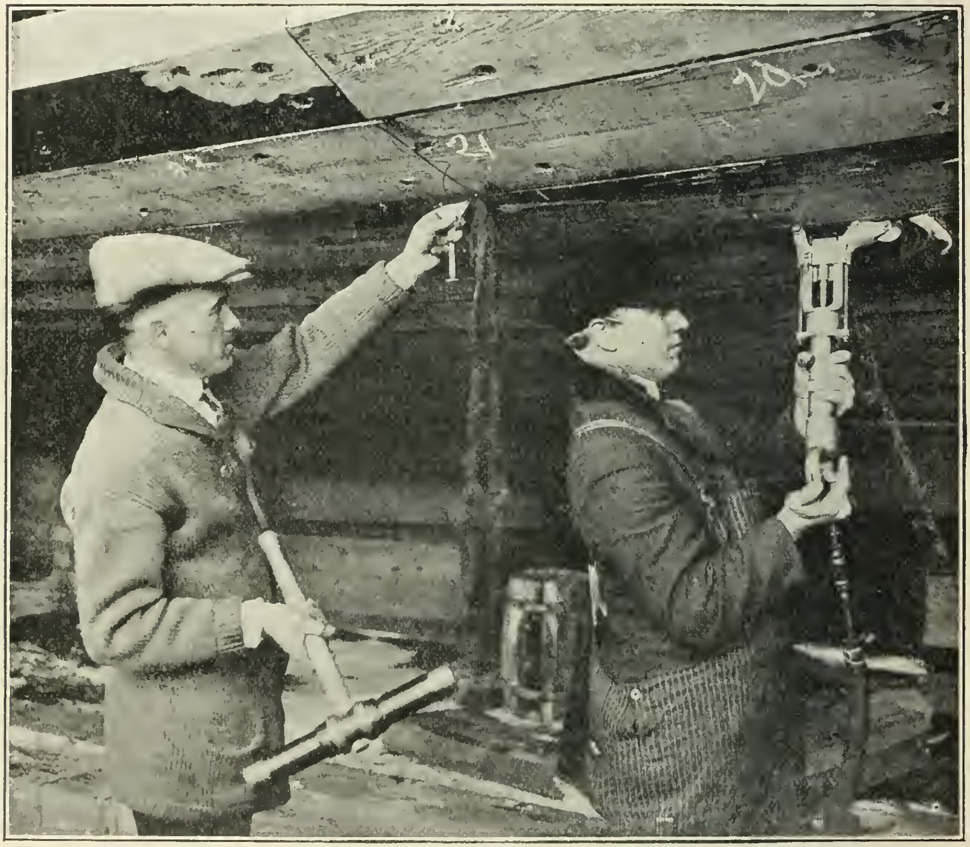
A gas that is used for welding and cutting, in the same manner as acetylene, is acetylene enriched with the heated vapors of crude oil. The special feature in its production is the use of cartridges of material, consisting of alternate layers of calcium carbide and sawdust soaked in oil. It is necessary to wash, purify and cool the gas, which is generated automatically in a portable apparatus, as needed, and delivered to the torch at 15 pounds pressure.

It is well known that the volume of lime into which the calcium carbide is converted by the slacking process is greater than the volume of the carbide. Therefore, when carbide is packed tightly in cartridges, as desirable, the expansion is likely to burst the case and in some cases it might cause the cartridge to jam in the chamber, as well as interfere with the successful working. One of the objects, then, is to make the cartridge so as to allow for the expansion of the contents. Another, is to prevent the oil from coming in contact with the carbide, as this would interfere with the action and decrease the gas output.

The cartridge consists of a tin can of suitable size, the smallest being 4⅜ inches in diameter and 8 inches high, weighing 6 pounds and having a gas producing capacity of 25 cubic feet; the largest 9¾ inches in diameter and 16 inches high weighing 40 pounds. A cylindrical screen is first placed in the can to be filled and then a layer of carbide is placed in the bottom of the can around the screen tube. An unglazed cardboard disc is next placed on top of the carbide. A space, made of thin metal bent so as to lie edgewise, is placed on top of the cardboard and then a disc of screen is put over it. Sawdust in a cloth sack, impregnated with crude oil, is laid on the screen, then a space and a cardboard disc and so on to the top, ending with a sack of oil-soaked sawdust covered with a piece of screen that has no hole in the center for the cylindrical tube. The end of the can is closed with a cover for handling, which is removed before placing the can in a generator.

The water, feeding in through the valve in the cartridge chamber, dips down through the cylindrical screen tube and starts slacking of the cover layer of carbide, the heat of which vaporizes the oil in the sack above it. The cardboard discs, while strong enough to hold the layers firmly in place while dry, begin to soak up as soon as the feeding starts and consequently become soft so as to give way under the pressure of the expanding carbide, allowing it to be forced into the spacing between the carbide and the oily sawdust. Steam or water vapor must pass through the absorbent cardboard as well as the oil before it reaches the next layer of carbide. Action of the steam on the carbide above is thus prevented. This insures that the respective layers of carbide will not be acted upon until the water becomes level with them in turn. In consequence a cartridge can remain in a generator a long time without being spent. The screen discs in top and bottom of each layer of oily sawdust furnish efficient volatilization and egress of the gas.

There are several claims made for this new gas. It is heavier than air, and it is said it can be used at a lower pressure, slightly over 1,400 pounds, and at the ordinary atmospheric temperature; but it is not explosive when liquefied. The explosive ratio is from 12 per cent. to 30 per cent. air. An excess of oxygen is not required in the welding flame, so that there need not be any reduction of the carbon in the iron or steel which is being welded, thus producing a soft weld.—*Scientific Amercian.*



THE OLD WAY AND THE NEW WAY OF CALKING

A CALKING MACHINE TO SPEED UP SHIPBUILDING

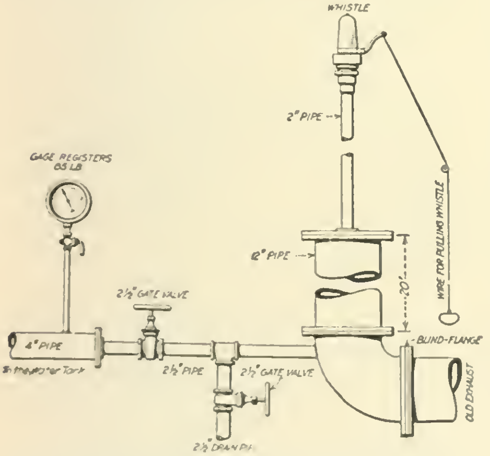
American shipbuilders will be specially interested in learning of the perfecting of a practical pneumatic caulking machine. The tool here shown should greatly accelerate the speed of wooden shipbuilding, which up to now has been hindered by the scarcity of competent calkers. It goes without saying in these times that any device which will speed up shipbuilding, or, for that matter, any war industry, is at once to be not only welcomed but put to work to the full extent of existing opportunities.

The tool shown in the half-tone is the Little David calking machine now being put on the market by the Ingersoll-Rand Company. It is entirely beyond the experimental stage and is an assured success wherever introduced.

The machine weighs but 13½ lb. and performances critically observed have shown that it can be easily handled and operated in any position. It automatically tacks either machine or hand-spun oakum in side or bottom seams to any depth required for final horsing. On deck planking it will also do the horsing. Its working speed is about 1500 tacks per minute either coiling or running the oakum straight.

The Little David calking machine is controlled by a trigger similar to that of a light scaling hammer. It differs, however, from the usual hammer in that the piston has an extended rod fitted with a thin calking blade. This, being a reciprocating iron with positive pull-back, has no tendency to bind. The calking iron travels in guides which prevent it from turning, the whole being fitted with springs so that the workman can vary the penetration of the iron with the varying depth of the seam. A unique device automatically feeds the oakum with each movement of the calking blade. Guide wheels run in the seam being calked and keep the threading iron lined up. The tool operates with negligible vibration, and it follows without effort on the part of the workman; in fact, machine calking is made so simple that ordinary workmen can do highly efficient work. The tool measures 22 inches in length over all. The ordinary equipment consists of a calking iron 1/16 in. thick, although an ⅛ in. iron can be furnished if required.

A demonstration was recently conducted before the U. S. Shipping Board Emergency Fleet Corporation and the tool was approved.



A WATER WHISTLE

By Frank Huskinson

Central station power was installed at a certain mine. The power house was converted into a substation. As there was no necessity for keeping up steam, the use of the boilers and engines was discontinued. Then it was discovered that the steam whistle which had signaled the time of starting and stopping work could not be sounded. I decided to try a scheme of blowing the whistle by means of water and air. The water tank was located upon a hill. The pressure at the boiler house was 85 lb., and we had plenty of water.

Part of the old exhaust line from the engines consisted of a 20-ft. length of 12-in. pipe which extended vertically from the floor up through the roof of the boiler house. I removed the exhaust head from this piece of pipe and put on a special flange that reduced the 12-in. pipe to a 2-in. opening. Then I took a piece of 2-in. pipe 18 ft. long and secured the old steam whistle to one end of it. The other end I screwed into the opening on top of the 12-in. pipe.

On the bottom part of the 12-in. pipe I put in a blind flange. I also made a connection in the 12-in. pipe for a 2½-in. pipe. Into this opening I screwed a short piece of pipe. Onto this I screwed a tee, then another short piece of pipe and a gate valve. This was connected to the 4-in. water line from the tank. The outlet of the tee was then fitted with a short piece of pipe and a gate valve from which a section of pipe was run outside the building as a drain.

The accompanying diagram shows the details of the pipe connections and whistle. All joints were made air-tight. The whistle was of a type that is operated by means of a quick-acting valve. This was opened by pulling a wire. The operation of the "water whistle," as it was called, was simple and quite satisfactory.

The valve for draining the 12-in. pipe was opened, also the whistle valve on top was held open, and all the water was allowed to drain out. Then the whistle valve and the drain valve were closed, and the valve on the water line was opened wide, allowing the water to flow into the 12-in. pipe. This was done about 30 sec. before the whistle was to be blown. Next the wire that opened the whistle valve was pulled, allowing the whistle to blow.

The action of the apparatus was as follows: The draining of the 12-in. pipe with the whistle valve open allowed the pipes to fill with air at the ordinary atmospheric pressure. As soon as water from the main was turned into the pipes, all other outlets being closed and air-tight, the air inside the pipes was compressed to the pressure of the water, which is 85 lb. As soon as the whistle valve was opened the air that rushed through the whistle had almost as much effect on it as had the steam used formerly. The water entering the pipe kept the pressure almost constant, and the whistle could be blown for several seconds or for short blasts. After each blowing of the whistle it was necessary to drain off the water from the 12-in. pipe, as described in the preceding paragraph, and this being done at once the whistle was always ready for use.—*Coal Age.*

THE MAGNITUDE OF THE TRENCH GAS PROBLEM

While the daily press has kept us perhaps sufficiently informed of the fact that poisonous gases are now employed as weapons of kultured warfare few of us have realized their deadly efficiency or the extent to which they are being employed. At a recent meeting of the Chicago section of the American Chemical Society Major S. J. M. Auld, chemical adviser of the British Military Mission thrilled the audience for nearly two hours with his description of the havocs of gas in twentieth century warfare. He described the first gas attack made by the Germans early in the war and the gallant resistance of the heroic men who met it without even the most primitive means of defense. He proceeded to tell about the development of the gas offensive from the first gas-cloud attack with chlorine to the use of phosgene, various tear and sneeze-producing gases, poison gases, and finally the latest accomplishments with gas shells. The great magnitude with which some of these attacks were carried on may be impressed upon us by learning that hundreds of tons of liquid chlorine have been used in a single attack, and that in some cases the drums of chlorine were placed so closely together that there were three for each two yards along a front of considerable length. The effect of weather conditions, the direction and velocity of the wind, the factor of safety, and many other details were explained.

In recent attacks with gas shells, as many as 35,000 to 50,000 shells have been dropped on a limited acreage in two or three hours. Some of the gas shells contained, in addition to the bursting charge of high explosive, bottles containing liquid, and in some cases even solid chemicals, which would be so completely atomized by the bursting of the shell that they would have the same effects as shells charged with liquefied gases. It was stated that a case was on record in which a shell which failed to explode was examined and found to contain bottles with the orginal Kahlbaum labels still intact.

Passing to the defensive, the speaker described the development of the gas mask from a simple cloth bandage soaked in various chemicals to the elaborate mask which is now in universal use. As fast as the enemy introduced new devices for gas offense a suitable defense was provided to overcome it. The experience was bitter and costly, but at the present time the idea is prevalent that the worst is over, and that the defense is, in general, developed to a greater degree of efficiency than the offense.

It was very gratifying to hear him say that the mask produced by the Americans, and now in general use at the front, was considered superior to any of the others. Not only are the men provided with masks, but even the horses, mules and carrier pigeons are provided for. In the case of the horses and mules, as these animals breathe through the nose, a mask made of cloth soaked in chemicals is drawn over the nostrils. In the case of the pigeons, however, each bird is not provided with a separate mask. The cages in which they are confined are covered with preparations which prevent any of the objectionable gases reaching the interior.

In the composition of gas masks designed to neutralize the effects of chlorine and phosgene, the chemicals most used are sodium thiosulphate, sodium phenate, activated charcoal, and hexamethylene-tetramine.

SHOVELING THE GASES OUT.

In our report of Major Auld's lecture nothing appears as to the operations necessary for getting rid of the gases. As they are specifically much heavier than atmospheric air they naturally seek out and settle in the lower levels. The gas clouds penetrate trenches and deep dugouts, and in most cases it is a matter of many hours before they become sufficiently diluted with the atmosphere to permit of safe breathing. So the matter resolves itself into a problem of driving the poisonous fumes out of the trenches and underground shelters, or at least thinning them out until the air is again made safe. And this is done in the most common sensible way in the world. The gases are simply shoveled out, and actual photos of the operation have been exhibited. The broadest scoop-shovels are employed and to these are added wings or flappers at the sides. Men employed in this work of course use respirators and are relieved at frequent intervals.

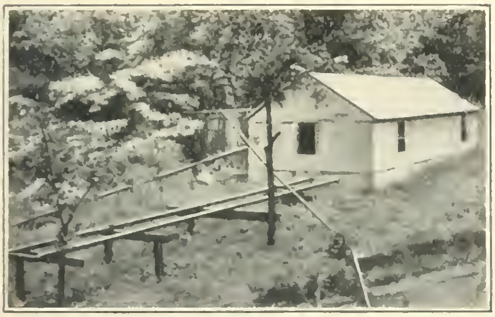


FIG. 1. AIR COOLING PIPES

COMPRESSED AIR INCREASING PRODUCTION OF OIL WELLS

What follows is abstracted from Bulletin 148, Petroleum Technology 37, of the Bureau of Mines. What is known as the Smith-Dunn process, first employed near Marietta, Ohio, for stimulating the production from oil wells by forcing air through the oil sand, is known to have been employed on over 90 properties, of which at least 80 per cent have been successful.

The essential principle of the Smith-Dunn or Marietta process is to replace the natural gas, which originally accompanied the oil and was the principal agent in forcing the oil into the wells but has been exhausted, with compressed air. The air is forced into the sand under pressures varying from 40 to 300 pounds through some of the wells on the property, which are called "air wells," the oil being pumped from the other wells in the usual way. Any gas which does not combine with the oil chemically under the conditions existing underground could be used, but of these gases only air and natural gas are practically available. On the old, nearly exhausted properties where the process has been employed natural gas is seldom available, or only at excessive costs, and it is seldom practicable to us anything but air.

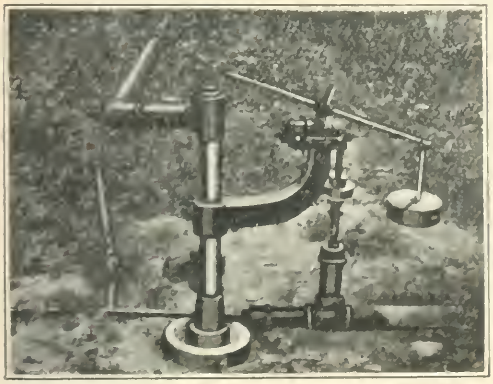


FIG. 2. OIL PUMP RUN BY AIR

EQUIPMENT REQUIRED

The extra equipment necessary for using the process over that commonly used on any producing oil lease consists of an air-compressor plant, a system of piping for conveying the compressed air to the air wells, and the preparation of certain wells for taking air.

The air compressor can be of any efficient type, and is usually driven by a gas engine, because gas is in nearly every instance the cheapest and most available fuel. However, any other type of engine can be employed. The tendency has been toward using direct-driven types because of greater efficiency and compactness.

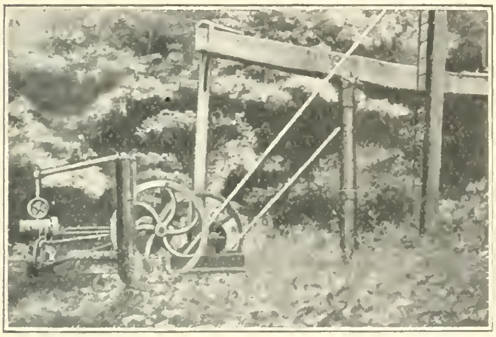


FIG. 3. BEAM PUMP AIR DRUM

The compressors in use vary in size from 20 to 100 horsepower. It is considered advisable to restrict the size of the units to 100 horsepower, and where more power is needed to install additional units. Where the air is compressed to a pressure of more than 100 pounds, two-stage compressors are generally used.

The compressed air is distributed through 2-inch to 4-inch mains, with 1-inch laterals leading to the air wells. With the distances and the velocities of air used on the ordinary plant, these sizes are large enough and the pressure losses due to friction do not warrant the extra cost of increasing the size of the pipe. The air should be conducted through a cooling system near the compressor Fig. 1, and the water drained off in taps, otherwise

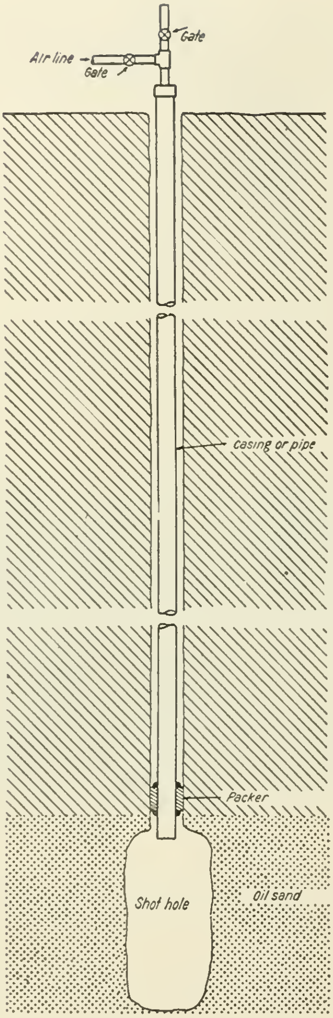


FIG. 4

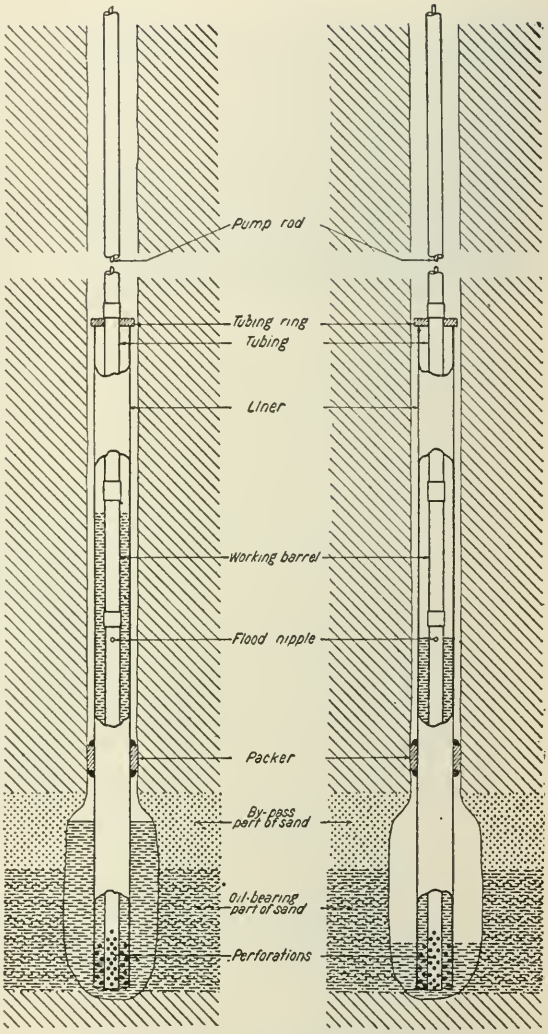


FIG. 6.

it will give trouble in the lines, especially in winter.

It is also necessary to have a gas-gathering system from the pumping wells to supply fuel for the compressor plant. These usually consist of 2-inch lines, and the system is essentially the same as on the ordinary lease where casing-head gas is used for fuel or for making gasoline.

The well-pumping equipment can be of the usual kinds, but as the compressed air can be used as a source of power there has been a tendency to put in pumps operated by compressed air. Figs. 2 and 3 show types of such pumping equipment.

The oil-gathering equipments are of the usual kinds, and the only effect that the use of compressed air has is to reduce the number of pumping wells, and therefore the amount of such equipment necessary.

The essential equipment in an air well consists of 1-inch or 2-inch piping or tubing which extends down to the top of the oil sand and is packed or cemented directly above the sand (see Fig. 4). If the well is cased directly above the sand the air may be intro-

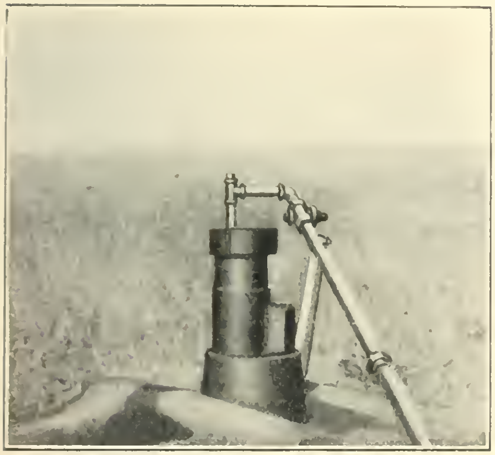


FIG. 5. WELL PIPED FOR AIR

duced through the casing (see Fig. 5). Where the pumping wells are fitted to take back pressure it is necessary that provision be taken, as in air wells, to prevent the waste of air, and, in fact, the possibility of leakage should be carefully considered at all points in the system because leaks in the air lines or the diffusion of the air into unprotected formations through air wells, pumping wells, or old abandoned wells will greatly reduce the efficiency of the method. The same can be said of the pumping equipment, and steps should be taken to prevent the unnecessary escape of air from pumping wells.

PREPARING AIR WELLS

One of the most important considerations in preparing wells for taking air is to not let the air have access to any formations other than the oil sands, otherwise large quantities of air may escape into the barren strata and be wasted. If the well has a string of casing tightly seated on the top of the oil sand, the air can be let into the top of the casing through a tight head or cap (see Fig. 5). When the well is not cased in this manner, a string of small pipe or tubing is placed in the well and packed at the top of the sand, as shown in Fig. 4. One inch pipe has been used in shallow fields, this sometimes being the only pipe in the hole.

It has not often been considered necessary to shoot the air wells. They should, however, be cleaned out, and sometimes it is advisable to remove the waxy sediments that clog the surface of the sand. Newly drilled wells have the advantage of the sand being perfectly clean and free from waxy sediment. Occasionally a combination well is made by forcing the air down between the casing and tubing in a pumping well. Such a well can be used as an air well for a time and then be pumped when the air is stopped and the oil comes back under the released pressure.

PREPARING PUMPING WELLS

In preparing the wells on a property for the use of compressed air, ordinarily no changes need be made in a pumping equipment unless it is old and out of repair. However, the process is frequently installed on properties where the equipment has been allowed to run down because the small profits have not permitted repairs and replacements.

It is sometimes desirable to maintain back pressures in the pumping wells on the oil sand. There are several ways of preparing a well for the use of regulated back pressure, the simplest being to place a reducing valve on the gas-gathering line from the casing head. When pressure is maintained in the well by this

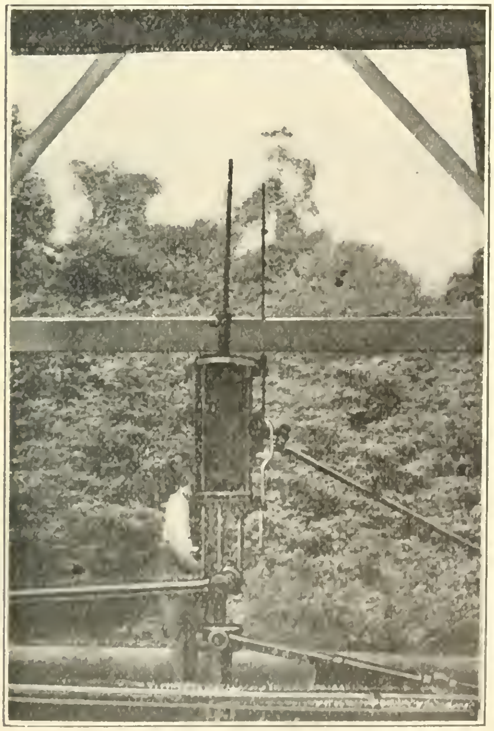


FIG. 7. PUMP HEAD RUN BY AIR

means, the formations overlying the oil sand should be cased off so that the gas will not waste in the same way as it would in an air well not cased off. Another method for maintaining back pressures in the wells is shown in Fig. 6.

Although the process does not require changing the type of pumping equipment, a logical development will be a greater use of compressed air in the future as the source of pumping power on leases employing the process. The power is centralized, and the air is readily distributed without much loss in power or trouble in operation. In many eastern fields the wells were pumped by compressed air long before the process of forcing compressed air into the sands came into use.

At Bradford, Pa., the compressed air is also used to run steam engines, pumping wells "on the beam" or in "air heads." Air lifts have been tried in the eastern fields, but were never satisfactory. Smith and Dunn use air displacement pumps on many of the shallow wells where their process is employed. On a few of the properties some of the wells have displayed a tendency to flow; and it is possible that with the proper application of the air the wells can sometimes be made to flow their productions.

PROPORTION OF AIR WELLS

The proportion of air wells to producing wells will depend not only on the local conditions on each property, but also on the principle on which the process is being operated. If back pressures are being used, different factors enter into the problem from these more pertinent if no back pressures are being maintained. Experience without the use of back pressure indicates that the best practice is to distribute many air wells as uniformly as possible among the producing well. More recent experience with the use of regulated back pressures indicates that fewer air wells are necessary, and that the wells so used can be chosen by their capacity for taking air rather than because of their central location among a group of producing wells. Where back pressures have not been used the tendency has been to increase the proportion of air wells, the average among 34 properties tabulated being 1 air well to 2.6 producing wells. At first consideration the operator is apt to think that as few air wells as possible should be used, but experience has shown otherwise.

SMALL PORTION OF CAMP GRANT

AIR LIFT PLANT AT CAMP GRANT

The following we abstract from an interesting paper by Chas. B. Burdick in the Journal of the Western Society of Engineers.

Camp Grant, at the junction of Rock and Kishwaukee Rivers, five miles below the center of Rockford, Illinois, comprises 5,620 acres, or about 9 square miles. The larger part of the reservation is devoted to the rifle range and maneuvering ground. The camp proper provides quarters for 42,000 men and 10,000 animals. There is a total of 1,520 buildings, all of modern construction, ranging in size from 60 ft. by 160 ft. down to about 14 ft. square. The greater number of buildings are the company barracks, which are two-story structures 43 ft. by 140 ft.

WATERWORKS SYSTEM

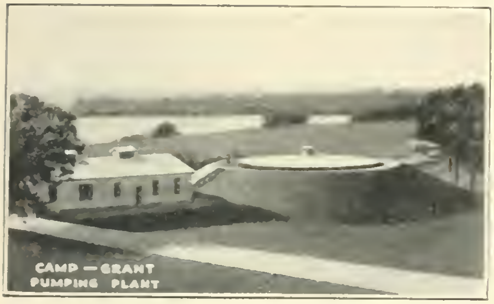
The water supply is obtained from six wells 10-in. in diameter and ranging in depth from 154 ft. to 185 ft. The water is drawn from a coarse sand stratum through Johnson brass strainers from 15 to 20 ft. in length.

The water is pumped from the wells by the air lift system, under a head of about 45 ft., to a circular concrete reservoir containing 300,000 gallons, from which the high lift pumps draw the water and deliver it to the distribution system. Air is supplied by three electric driven two-stage short belted Ingersoll-Rand air compressors, at present operating at about 60 lbs. air pressure.

The high lift pumps are electric driven with the exception of one oil engine unit provided for emergency service. The station contains four electric driven centrifugals having a capacity each of 1,000 gallons per minute against 180 ft. head.

WHY THE AIR LIFT?

In the construction of the system of wells for the water works no time was available to explore the underground conditions by test wells



COMPRESSOR HOUSE AND RESERVOIR

WATERWORKS UNDER CONSTRUCTION

to determine what would be required as to well strainers, casings and well pumping equipment. It was necessary to anticipate all possible conditions and to place orders for all well casings and well drilling equipment that would possibly be required.

Experience in northern Illinois made it certain that a supply of water could be obtained in the St. Peter sandstone with wells about 500 ft. deep, but the time required to drill to this depth made it desirable to develop the water in the sand and gravel overlying bed rock, if this could be done. Experience in the City of Rockford was not favorable to these shallow wells. Therefore, it was not considered safe to make plans for a supply nearer the surface than the St. Peter sandstone. Accordingly, casings and well drilling equipment were mobilized for deep wells. At the same time accurate records were kept of the strata encountered from the ground surface, and a strainer was provided, so that if favorable materials were encountered, the strainer could be set and a well test could be made. Fortunately, the shallow supply was successful, and with the first successful well, additional strainers were provided and used in the remaining wells as rapidly as the drill rigs reached the water bearing sand.

Likewise in the design of the pumping equipment, provision was made for every contingency reasonably possible. In the light of developments, it would be possible to develop a supply by suction. It was known that this could be done before the work started, but if it had been necessary to develop water in the St. Peter sandstone, the supply per well by suction would have been so small that a large number of wells would have been required, thus defeating our purpose through the consumption of too much time. Furthermore, as a proposition for water supply during the period of war, it would be economy to construct a few wells and pump them deep, rather than a larger number of wells pumped by suction to a shallow depth.

For this reason, and further on account of its reliability, the air lift pumping system was adopted, and it was so designed that the desired supply could be pumped from a depth of 100 ft. if necessary. Fortunately, capacious wells in the sand and gravel permit of the required supply with a lift of about 45 ft., and, therefore, there is a reserve of capacity in the air lift pumping equipment in addition to one compressor unit held in reserve for breakdowns.

COOLING FORGINGS BY COMPRESSED AIR

A method of cooling forgings by compressed air, with decidedly beneficial effect upon the steel has been developed by J. W. Dunphy, a Canadian engineer. Steel containing 0.42 per cent carbon, 0.063 silicon, 0.034 sulphur, 0.025 phosphorus, and 0.48 per cent manganese, which with appropriate heat treatment when cooling under atmospheric conditions gave a yield point of 18 tons and a tensile strength of 36 tons per square inch with 27 per cent elongation, after being cooled by compressed air is said to have improved its yield point to 22 tons and its tensile strength to 44 tons per square inch with 25 per cent elongation. The forging was a 9.2 inch shell, and the air consumption 2100 cubic feet per minute. The air was used at a pressure of 80 pounds per square inch and was delivered from a pair of 2-inch pipes, plugged at their ends, surrounding the forging and with fifty 3/16-inch holes each on the side facing the forging, while a 3-inch pipe with one hundred

3/16-inch holes along its length and ending in a special nozzle to cool the nose of the shell, cooled the inside. It took five minutes to reduce the forging from furnace heat to 800 degrees Fahr. While being cooled it rested on a pair of 4-inch rollers, one of which was driven by a compressed air motor, while the other ran as an idler. The 3-inch pipe supplying the compressed air to the cooling pipes was about 10 feet long, and had a loose joint at the top, so that all the pipes could be lifted and swung away when the forging was changed.

Coals having different composition require different sizes of combustion space. The chemical characteristics that are most likely to affect the size of the combustion space required for a given set of conditions are the quantity and quality of the volatile matter. The quantity of the volatile matter is shown by its percentage as determined by the proximate analysis. The quality of the volatile matter is indicated approximately by the ratio of volatile carbon to available hydrogen, and probably also by the oxygen content of the coal on a moisture and ash free basis.—*Bureau of Mines Bulletin No. 135.*

SOME ENGINEERS*

Who is the man designs our pumps with judgment, skill and care?
Who is the man that builds 'em and who keeps them in repair?
Who has to shut them down because the valve seats disappear?
The bearing-wearing, gearing-tearing mechanical engineer.

Who buys his juice for half a cent and wants to charge a dime?
Who when we've signed the contract can't deliver half the time?
Who thinks a loss of twenty-six per cent is nothing queer?
The volt-inducing, load-reducing electric engineer.

Who is it takes a transit out to find a sewer to tap?
Who then with care extreme locates the junction on the map?
Who is it goes to dig it up and finds it nowhere near?
The mud-bespattered, torn and tattered civil engineer.

With compressed air and dynamite, who toils in dark and wet,
The copper, iron, coal and gold for all the world to get?
Who sinks his shafts and drives his stopes and makes the wealth appear?
The drilling, blasting, pumping, hoisting mining engineer.

Who thinks without his products we would all be in the lurch?
Who has a heathen idol which he designates Research?
Who tints the creeks, perfumes the air, and makes the landscapes drear?
The stink-evolving, grass-dissolving chemical engineer.

Who is the man who'll draw a plan for everything you desire?
From a trans-Atlantic liner to a hairpin made of wire?
With "ifs" and "ands," "howe'ers" and "buts" who makes his meaning clear?
The work-disdaining, fee-retaining consulting engineer.

Who builds a road for fifty years that disappears in two?
Then changes his identity, so no one's left to sue?
Who covers all the traveled roads with filthy oily smear?
The bump-providing, rough-on-riding highway engineer.

Who takes the pleasure out of life and makes existence hell?
Who'll fire a real good-looking one because she cannot spell?
Who substitutes a dictaphone for coral tinted ear?
The penny-chasing, dollar-wasting efficiency engineer.

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*[Mining engineer interpolated by C. A. M.]
Sung to the Tune of "Son of a Gambolier," at a Meeting of the Engineering Society of Buffalo.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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I accept the challenge. I know that you accept it. All the world shall know that you accept it. It shall appear in the utter sacrifice and self-forgetfulness with which we shall give all that we love and all that we have to redeem the world and make it fit for free men like ourselves to live in. This now is the meaning of all that we do. Let everything that we say, my fellow-countrymen, everything that we henceforth plan and accomplish, ring true to this response till the majesty and might of our concerted power shall fill the thought and utterly defeat the force of those who flout and misprize what we honor and hold dear.

Germany has once more said that force, and force alone, shall decide whether justice and peace shall reign in the affairs of men, whether right as America conceives it or dominion as she conceives it shall determine the destinies of mankind. There is, therefore, but one response possible from us: Force, force to the utmost, force without stint or limit, the righteous and triumphant force which shall make right the law of the world and cast every selfish dominion down in the dust.—

OUR PRESIDENT.

WE ALL ARE IN THE FIGHT

These are the times when history is being made for only the far ages to fully interpret. On the face of things and in the rapid flow of events it is not easy to realize that up to the present this is the most critical and portentous period in the great life of the world, and that we of America are as fully involved as any. Our position as a nation is in like jeopardy and our future in the same uncertainty as that of the dwellers across the seas. At the present writing no man may deduce from the visible trend of events what is to be the outcome. And yet the sub-current of our national life is not greatly disturbed. All of life's activities are in full swing. The masses of our people are apparently as prosperous as ever within our memory, crowded with remunerative employment, and, the clouds and the thunders and the earthquake rumblings all ignored, there are those who still could dwell among us in smug content.

Nevertheless, there are few among us who are not seriously thinking and more or less realizing that a struggle for life is upon us. It is a thing absolutely unescapable. There is no possibility of giving up to or of settling with these reeking foes of the human race at any price. We must conquer completely or be hopelessly bound in practical slavery to foreign military tyrants for years uncountable. Such a step backward would be a reversal of the entire recorded course of the human race. Our way is upward and not downward. As the true American patriot never despaired of the republic so the true man of the world never despairs for humanity. All along the way, however, man has had to pay the price, too often in drenches of blood, and only ages after is it seen to be a bargain for us.

The progress of civilization, as we have been wont to call it, has had no more transforming effect than in the arts and conditions of warfare. The hero at the front was never more a hero and the risks to be faced were never so great. With a full realization of this all of America's young manhood is crowding forward as fast as it can be organized and equipped and transported. The assurance of ultimate success is all in the providing and equipping, and the soldier at the front is only a helpless victim if these shall fail him. This puts the responsibility upon us all, for we all have a hand in these things. A single battle may be won by the personality of the command and that of the men engaged, but even then they must be lavishly, unfailingly supplied with the swiftly wasting munitions and everything right at hand for their instant needs, while for the conduct of a campaign the requirements go far beyond our powers of enumeration. The call is for the product of all our factories and all our farms, the maintenance of financial stability, unwavering confidence and resolve whatever may befall, and this puts a burden of responsibility, commensurate with ability and opportunity, upon us all.

The New York subway, with 136 miles of track, hauls more than two and one-half times as many passengers as the number hauled by the Pennsylvania Railroad with its 26,000 miles of track. And the Pennsylvania stretches through thirteen states and the District of Columbia.

PREVENTING FREEZING IN AIR PIPING

It should be understood that what follows, from the *Electric Journal,* refers entirely to the air brake equipment of surface railway cars. Contrary to the general impression freezing is not so troublesome when the atmospheric temperature is very low as it is when only a trifle below the freezing point, because at low temperature most of the moisture has been frozen out of the atmosphere. The installation of air piping should be such that the maximum amount of moisture is retained in the main reservoir and no pockets should exist where moisture is liable to collect. The pipe between the compressor and the main reservoir, as well as the pipe between the two main reservoirs, should be at least 25 ft. long, and when the length of car does not permit a straight run the pipe should be made in the form of horizontal coils.

A scheme which is similar to the pipe coil, but having the additional advantage of multiple paths, is the arrangement of a number of tubes fastened into two heads or drums. One of these drums can be used as a moisture trap, preventing the major portion of the moisture from getting into the main reservoir. For a given length of piping with the same diameter in the two systems one arranged in the single path and the other in multiple paths, the single path will require a greater velocity and hence a greater loss in pressure for the delivery of a given quantity of air.

In connecting the feed pipe to the reservoir particular attention should be given to make sure that the connections do not give a reduction of pipe area at any point, as the change in area increases the possibility of freezing. One of the most common breaches in the proper method of making an air installation is to use an "L" fitting at this joint, which not only gives a reduction of area but forms a trap for moisture to accumulate. A better and much more satisfactory scheme for this connection is to have a straight run or large radius bend to the main reservoir where possible and use a connector which does not give a reduction in area.

All piping from the reservoir to the various pieces of apparatus should be arranged to drain back into the reservoir as far as possible, and when this is impossible it should at least drain away from the apparatus.

There have been a number of installations where the compressor intake has been mounted inside and, in some cases underneath, the car. The best place to mount the intake is on the roof, as it is then possible to obtain cool, clean air. More moisture is obtained from the interior of a car than from the exterior, especially on a cold day, because the higher temperature of the air within the car permits the presence of more moisture per unit of volume of air.

Even in the best installations it is impossible to prevent considerable moisture from getting into the system and to prevent trouble from this source a rigid inspection should be maintained during the winter. It is a good practice to drain the main reservoir at least once a day and oftener if possible.

VALVES FOR LITTLE COMPRESSORS

We have lately received the following:

"The writer has just patented a two-cylinder, rotary, hand-action, automobile tire pump. That is, it is a pump which has a central frame which fastens to the running board by a clamp. On the side of the frame is mounted an internal flanged gear; just such a gear as is used on the outside wheel of a lawn mower. On the other side of the frame are two gears which mesh with the internal gear. A pitman arm is fastened on each small gear. The pitman arms work the plungers in the pumps. The gearing is in the ratio of 2½ to 1, 40 revolutions of the large gear giving 100 impulses to each piston. The cylinders are about 1¼ by 2¾ in. each. The two cylinders are siamesd together at the top with connection to the tire. It therefore is necessary to have an intake and a discharge valve on each cylinder. The writer has used the regular ball and spring check, but finds it is not rapid enough. The information desired is this. A quick opening, easy spring valve with an opening at least ½ in. Do you know of such a valve, or where the writer might get in touch with any manufacturer who would show a line of air valves?"

In reply to this we can only say that the intake and discharge valves of all good air compressors are designed and located as part of the machine and no valve manufactured commercially for mutilfarious uses can be satisfactory. There are various check valves for steam or water which might be employed, but their application would involve so much clearance space that the delivery would be greatly reduced, and for high pressures with such little cylinders there might be no delivery at all. In fact, we venture the opinion that excessive clearance, and not slow action valves, is the cause of the trouble our correspondent encounters.

AIR CARRIED POWDERED COAL

Powdered coal pulverized and distributed by the Holbeck system is being used for heating 46 sheet and pair furnaces at the plant of the Standard Tin Plate Co., Canonsburg, Pa. An interesting feature of the installation is the arrangement of coal dust collectors in both the distributing and pulverizing parts of the system. This is shown diagrammatically in one of the illustrations.

The pulverized coal is delivered to a main conveying duct and is carried in suspension in a continuous current of air, with branch lines leading to the furnaces. The conveyor duct forms a closed system through a return duct leading to dust collectors and thence to the air intake to the distributing blowers. Thus the only outlet is through the branch lines to the furnaces. The installation comprises two distributing blowers with inter-connected dust collectors and four pulverizers, which deliver coal through individual dust collectors to two powdered-coal storage bins. Two pulverizers supply a single bin. The illustration shows the arrangement of equipment attached to one of these blowers and pulverizers. The work of designing and erecting the equipment was done by the Bonnot Co., Canton, Ohio, under the personal direction of A. A. Holbeck, who is its chief engineer. Alterations to the furnaces to accommodate the system were made during shut-down periods on Saturdays and Sundays.

After running the sheet and pair furnaces for a period of several months it was decided to run a branch coal-dust main to an annealing furnace, also a similar line was carried to one of the tin pots in the tin house. Additional equipment for preparing and distributing powdered coal to 18 annealing furnaces and 50 tin pots is now being installed and in a few weeks the Standard Tin Plate Co. will use powdered coal in all its heating work.

The pulverized coal plant contains three 9-in.

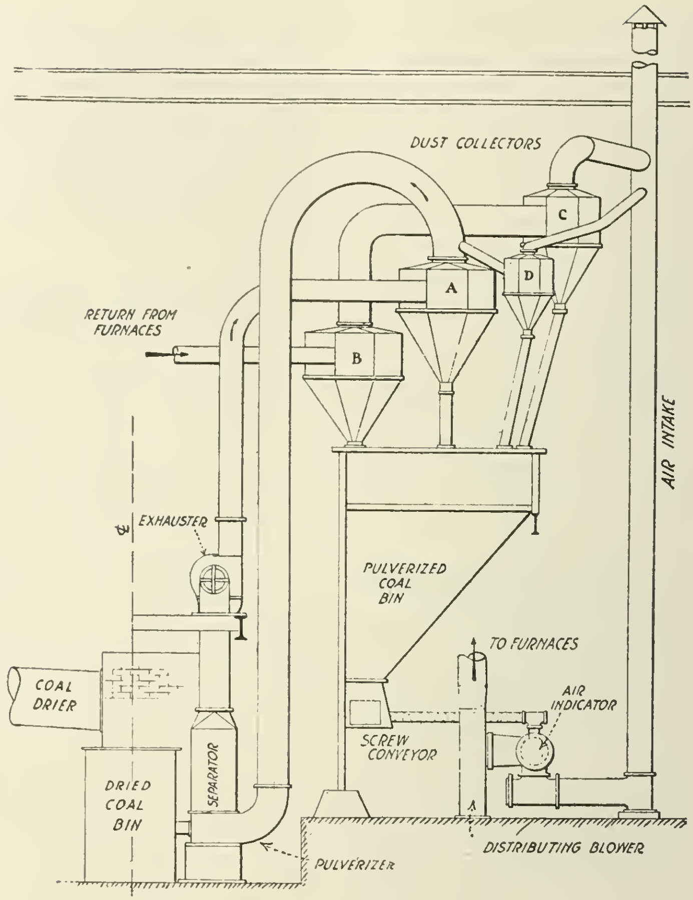


FIG. 1

screw conveyors placed in concrete trenches. These receive the coal from the coal storage pocket and deliver it to an 18-in. belt conveyor. After passing a magnetic separator which removes all foreign matter the coal goes to a bucket elevator. This elevates and discharges it through a spout to an automatic registering scale which weighs and drops it to a drier.

This drier, which is hand fired, removes the moisture from the coal so that only ½ per cent remains. There is not much danger of the coal taking fire as the velocity of the gases is low due to the large area of the drier. Also, the drier is provided with dust-tight rings at each end to prevent dust leakage.

From the drier the coal is conveyed by a screw conveyor to the two dried-coal bins, one being placed between two Bonnot pulverizers. Each pulverizer has a capacity for pulverizing 2500 lb. of coal per hour to a fineness of 95 per cent through a 100-mesh screen and 85 per cent through a 200-mesh screen.

After being pulverized the fine coal dust is drawn through an air separator on the top of each pulverizer and discharged into dust collectors, one for each pulverizer. From these the coal dust drops to the storage bins while the air is drawn back to the pulverizers maintaining a partial vacuum in them. This, it is said, insures an absolute quality of fineness of grinding and incloses the system so there is no escape of coal dust to the atmosphere. Also the combustible gases released by pulverizing the coal are kept in the system and delivered to the suction piping of the distributing blowers.

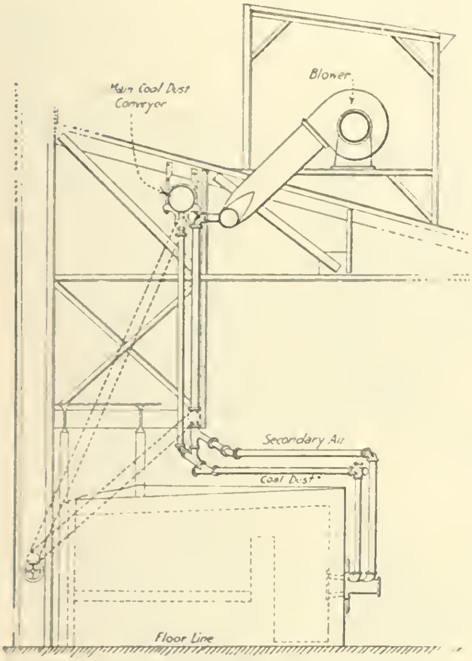


FIG. 2

The powdered coal is fed to a cast-iron high pressure distributing blower along with air in such proportion that it is carried by suspension through pipes to the different furnaces at a velocity of approximately a mile a minute. The coal dust and air traveling through the pipe form a non-combustible mixture which requires additional air for combustion of the coal. This is furnished under a small blast pressure at the coal burner.

The amount of coal dust and air fed to the distributing blower is governed by a regulator which in turn is governed by the volume of air flowing through the line so that irrespective of varying demands on the system a constant mixture of coal and air will be delivered to the distributing duct. The regulator controls the speed of a variable speed motor which drives the screw feeding coal to the blower. A float controls the free air admitted to the blower with the coal dust.

The distributing pipe for the 46 sheet and pair furnaces is 1480 ft. long and is carried up and over and through the roof trusses with branches dropping down at each furnace to supply the burners. The method of dropping a branch pipe to the burner and also the manner in which the supply of coal and secondary air are controlled by the furnace operator are illustrated.

Approximately 600 lb. of coal, it is said, were required per ton of steel heated with hand firing while with powdered coal this was found to be reduced to 280 lb. per ton.

The following notes will be of assistance in interpreting the illustrations:

Fig. 1. Dried coal after pulverization is delivered through an air separator to the main collector A, from which it falls to the coal storage bin. A screw conveyor carries it from here to a distributing blower, which takes in air through the air intake and delivers the mixture to the main coal dust conveying duct. Coal dust not taken by the furnace continues through the conveying duct, which returns to dust collectors B and C. These are open to the air intake, but the coal settles to the bin.

Fig. 2. A branch line from the coal dust conveyor and one from the secondary air supply unite at the burner at rear of furnace. Provision for regulation by the operator and the elevated blower for the secondary air line are shown.

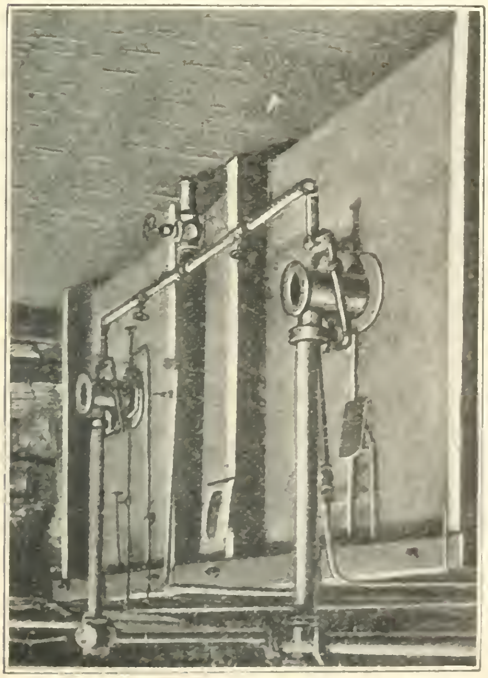
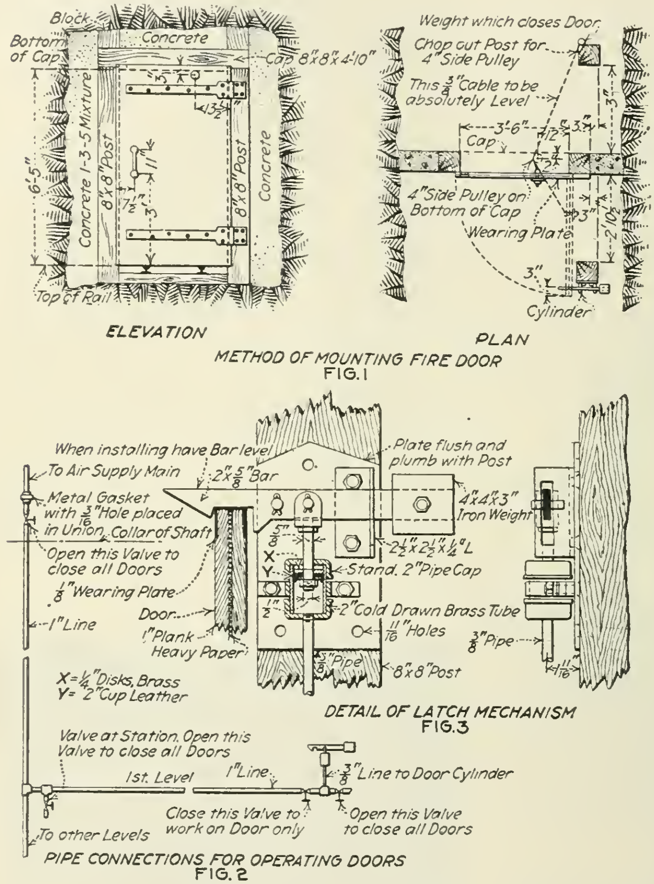


FIG. 3

Fig. 3. Burners at rear of sheet and pair heating furnaces, showing coal dust and secondary air supply.—*Iron Age.*



METHOD OF MOUNTING FIRE DOOR
FIG. 1

DETAIL OF LATCH MECHANISM
FIG. 3

PIPE CONNECTIONS FOR OPERATING DOORS
FIG. 2

COPPER QUEEN FIRE DOORS

FIRE DOORS AIR-CONTROLLED AT COPPER QUEEN MINE

In a paper before the American Institute of Mining Engineers, Feb., 1918, Gerald Sherman, Supt. of Mining Dept., Copper Queen Consolidated Mining Co., Bisbee, Arizona, describes an ingenious arrangement for closing fire doors simultaneously all over a mine by simply opening an air valve anywhere on the system from the surface to the stopes.

A sketch of the doors is given in Fig. 1, and a diagram of the piping system through which they are operated is shown in Fig. 2. Fig. 3 gives details of the operating mechanism. The doors are set in concrete, and are normally held open by a latch; when the latch is raised, the door is closed by a weight. The latch is held locked by an air cylinder acting against a counterweight. The air cylinders connect by piping, with all doors protecting the shaft and with the compressed-air main on the surface. By opening a valve at any station, or at the surface, the air system is drained of air, the pressure on the cylinder falls, and the weight throws the latch and allows the doors to close. Any door, of course, may be opened by hand afterward. A small hole in a metal gasket furnishes enough air to supply leakage in the pipe system but not enough to prevent the fall in pressure when any valve is opened. By this arrangement, if anything goes wrong with the piping or air pressure, the doors close automatically; if the latches were thrown by cylinder pressure, instead of the reverse, they would fail in case of accident to the air line or its injury by the heat of a fire not quickly discovered. It is probable that the doors cannot be made air-tight, but if necessary they can be easily and quickly caulked by helmet men, after they are closed.

NOTES

The United States is by far the largest both producer and consumer of talc in the world, according to the United States Geological Survey. The softness, absorptive capacity, difficult fusibility and solubility, and electric resistance of talc make it one of the most generally useful of all minerals in the arts and industries. Its principal military use is to prevent sore feet among marching soldiers. Only pure ground talc should be used for this purpose. The demand for the "footease" grade of ground talc, which is now extensively used in the army, may be fully supplied in this country. Although the war has stimulated production it has not greatly increased the price.

The following average weights per brake horse-power for various classes of engines were given In a paper by Mr. P. N. Everett, recently read at Newcastle on-Tyne:—Triple expansion steam engine for cargo boat (no boilers or auxiliaries), 130; triple expansion, including boilers and auxiliaries, 450; Diesel engine for cargo boat (no auxiliaries), 250; Diesel engine with all auxiliaries, 400; turbines, for cross-Channel boat with boilers and auxiliaries, 200; Diesel engines for submarines, 50; steam reciprocating engines for destroyers, 35; turbines for destroyers, with boilers, etc., 30; petrol engines for motor cars, 15; petrol engines for racing boats, 7½; aero engines, 2½.

An extraordinary engineering feat is under way at the quarry of the Morris County (N. J.) Crushed Stone Company. A tunnel about 70 feet has been dug under the mountain of rock considerably over 100 feet below the top of the rock. Lateral tunnels will be dug out from this main tunnel. Huge charges of explosives will be placed in these tunnels and at one blast over 30,000 cubic yards of stone will be crumbled. The face of the rock is 112 feet high.

A 9-ft. concrete-lined tunnel 7,000 ft. long is being planned for the City of Milwaukee. It will extend from the shore shaft of the new intake tunnel across the city to the proposed west side pumping station at Chambers street, on the west side of the Milwaukee River.

A new wood called balsa, growing principally in South and Central America, is remarkable on account of its lightness, microscopical structure, absence of woody fibre, elasticity and heat insulating qualities. So far as investigation has disclosed, it is the lightest commercially useful wood known. It has also considerable structural strength, which makes it suitable for many uses.

The new stack of the Tacoma Smelting Co. at Tacoma, Wash., exceeds all previous height records for chimneys. It rises 571 ft. above top of footing (just above ground level) and 601 ft. above foundation level. As it stands on a ridge about 150 ft. high, its top is 725 ft. above tidewater, only a few hundred feet away.

February 19, 1918, was the second birthday of the world's greatest gushing oil well. This well, which is almost the eighth wonder of the world, is the famous Cerro Azul No. 4 in the Mexican fields of the Pan-American Petroleum & Transport Co., of which E. L. Doheny, of Los Angeles, is president. Before it was capped and the flow controlled 260,858 barrels of oil had been tossed high in the air.

Completion of the 12-ft. Wilson avenue intake tunnel at Chicago marks an important step in the increase of water-supply for that city. The tunnel extends in solid rock three miles under Lake Michigan to an intake shaft and crib, and five miles under the city to a new pumping station. It is of horse-shoe section, 13x13 ft. for one mile from the intake shaft, and 12x12 ft. for the remaining seven miles.

In the best roundhouse practice locomotives of the larger types can be thoroughly cleaned in from seven to ten minutes by washing them with a combination of fuel oil and water sprayed through a nozzle by compressed air.

A process has been developed for production of gas from straw. An equipment for a farm will include a retort, scrubber and gasometer, and cost approximately $500. The straw is compressed in bales of necessary size. Gas begins to come off at approximately 200 deg.; a maximum temperature between 500 and 600 deg. is necessary. The gas is entirely removed in from 30 to 45 minutes. Each ton of straw produces between 10,000 and 11,000 cu. ft. of gas, also six to eight gallons of tar and ammoniacal liquor. Part of the gas is used in carbonizing the straw, leaving approximately 7,000 cu. ft. available. The gas has a calorific value of about 400 B.t.u. per cubic foot. One ton of straw gasified leaves about 600 pounds of carbon residue, which could be converted into lamp black or other carbon products. An experimental plant has already successfully produced this gas.

LATEST U. S. PATENTS

FEBRUARY 26

1,257,354. VACUUM VAPOR-HEATING SYSTEM. Henry J. Hunt, Chicago, Ill.

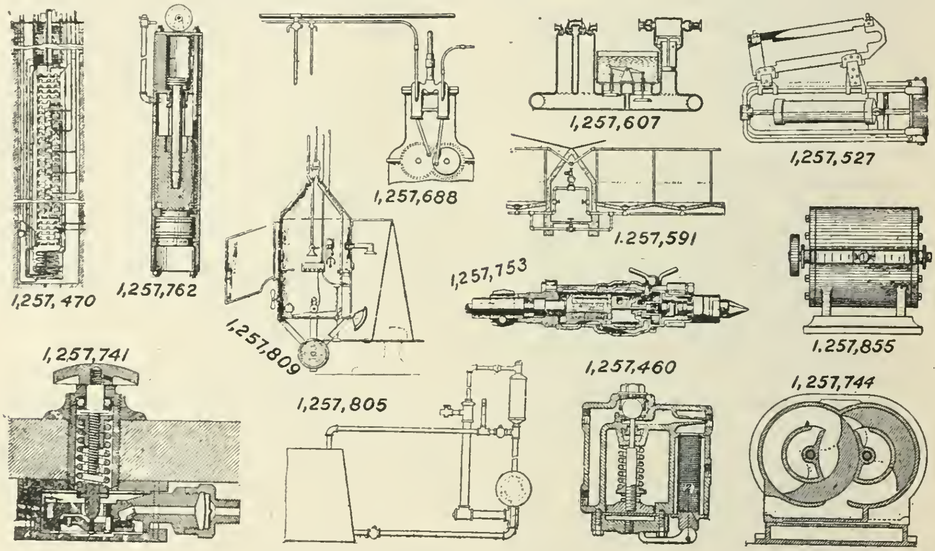
1,257,460. PRESSURE-REGULATOR. Lucian W. Cushman, St. Joseph, Mo.

1,257,470. APPARATUS FOR THE LIQUEFACTION AND RECTIFICATION OF AIR. Hendrik Filippo and Pancras Schoonenberg, Eindhoven, Netherlands.

1,257,527. AIR-PUMP. Gregory Victor Piotrowsky, Buffalo, N. Y.

1,257,584. PROCESS FOR PICKLING OLIVES. William V. Cruess, Berkeley, Cal., dedicated, by mesne assignments to the Government of the United States and to the people of the United States.

5. The process for pickling or curing olives which consists in subjecting the olives to a lye bath, and subsequently subjecting the olives in a tank to a heated liquid carrying minute particles of air in suspension, continuously withdrawing the liquid from the bottom of the tank, continuously adding air to said withdrawn heated liquid and intimately mixing said air and heated liquid and causing the mixture to flow back into the tank continuously.



Pneumatic Patents February 26

1,257,591. PROCESS FOR PREPARING FERTILIZING MATERIAL. Thomas A. Dungan, Chicago, Ill.

1. The herein described improvement in the art of forming fertilizer from sterilized organic material, which consists in inoculating the material with aerobic bacteria and permitting the bacteria to develop while continuously forcing air through the mass.

1,257,607. METHOD OF COMPRESSING AIR OR GASES. Herbert Alfred Humphrey, Westminster, London, England.

1,257,688. PULSATOR FOR MILKING-MACHINES. Robert Bruce Forsyth, Christchurch, New Zealand.

1,257,741. PRESSURE-REGULATOR. Percy Russell, Philadelphia, Pa., and Adoplh W. Schramm, Riverton, N. J.

1,257,744. ROTARY PUMP OR COMPRESSOR. Robert Schorr, San Francisco, Cal.

1,257,753. FLUID-OPERATED MOTOR. William A. Smith, Denver, Colo.

1,257,762. SUBAQUEOUS PILE - HAMMER. Thomas E. Sturtevant, Dover, N. J.

1,257,805. VACUUM FLUID - CIRCULATING SYSTEM. Sebastian L. Calvert, Augusta, Kans.

1,257,809. DIVING-BELL. Arnaldo Ceretti, Montreal, Quebec, Canada.

1,257,855. AIR-COMPRESSOR. Arthur Leonard Harrison, Victoria, British Columbia, Canada.

1. An air compressor comprising, a stationary cylinder having a spiral groove in the bore thereof and provided with diametrically located inlet and outlet passages for each end, a piston rotatably mounted in said bore and having pins slidably engaging the said groove at diametrically opposite points whereby rotation of the piston causes its reciprocation, means for rotating the piston, and means operated by the rotating piston for opening an inlet and an outlet passage at opposite ends of the cylinder simultaneously.

MARCH 5

1,258,033. AUTOMATIC CLOSING DEVICE FOR FIRE-DOORS. Frederick W. Martin, New York, N. Y.

1. In a fire door apparatus, the combination of a door, a cylinder and piston for operating the door, said cylinder having a normally open admission port, a manually operated valve for controlling the supply of fluid through said port, an expansion chamber, and a valve operated by the pressure in said chamber for automatically closing said port at a predetermined time after the opening of said manual valve.

1,258,060. VACUUM FUEL-FEEDING SYSTEM FOR GASOLENE-ENGINES. Harold C. Suckert, New York, N. Y.

1,258,079. SAFETY-VALVE FOR PNEUMATIC TIRES. William J. Young, Minetto, N. Y.

1,258,105. AIR PUMPER OR MOTOR CIRCULATION-CHECK. Robert A. Gally, Cincinnati, Ohio.

1,258,206. PNEUMATIC TOOL. Martin B. Fetcher, Detroit, Mich.

1,258,277. COTTON-PICKER. Walter Gee Upchurch, Nashville, Tenn.

In a cotton picker structure, the combination, of a cotton receiving chamber, means for removing cotton from said chamber including a pair of air suction fans having outlet pipes, flexible members communicating with inlets of said fans, a forked nozzle, the arms of said nozzle connected to said outlet pipes, said flexible members extending into said chamber whereby the cotton will be drawn therethrough into said fans and out through said forked nozzle upon operation of the fans.

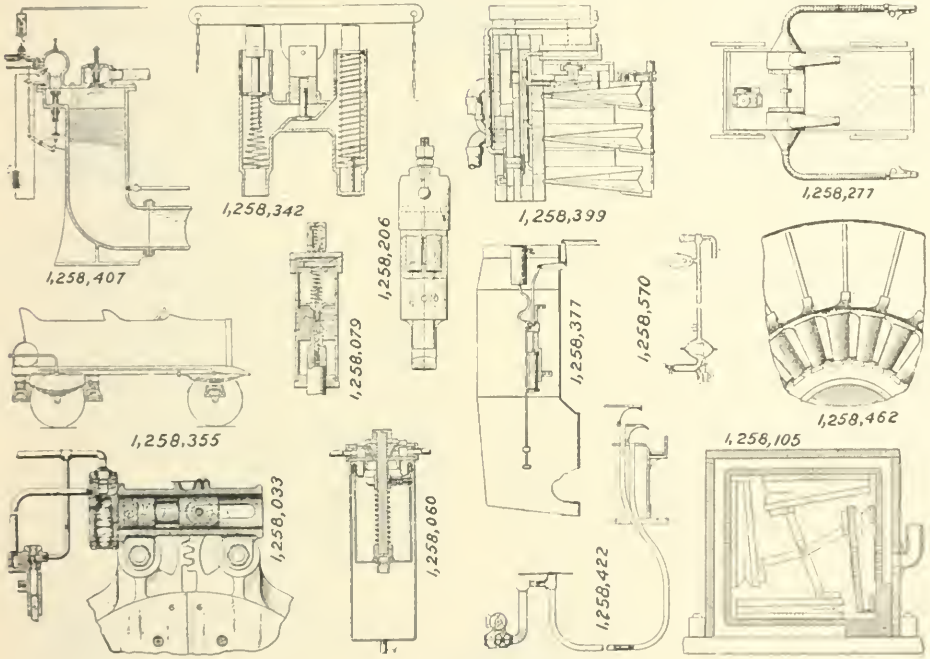
1,258,342. AIR-VALVE FOR HOISTS. Joseph J. Justen, Milwaukee, Wis.

1,258,355. PNEUMATIC RUNNING - GEAR FOR VEHICLES. Thomas J. Mullen, New Brighton, and Thomas F. Brennan, Tompkinsville, N. Y.

1,258,399. PNEUMATIC SELECTIVE DEVICE. Lewis B. Doman, East Syracuse, N. Y.

1,258,407. AIR-COMPRESSOR. Stirling B. Hill, Seattle, Wash.

1,258,422. PNEUMATIC - DESPATCH - TUBE. APPARATUS. Ernest J. Loring, Somerville, Mass.



Pneumatic Patents March 5

1,258,462. CENTRIFUGAL COMPRESSOR. Richard H. Rice, Lynn, Mass.

1,258,570. APPARATUS FOR UTILIZING AN EXPANSIVE FORCE. Herbert Alfred Humphrey, London, England.

MARCH 12

1,258,713. APPARATUS FOR PRODUCING POWER. David H. Smalley, South Pasadena, Cal.

1. In combination, a cylinder, a piston in the cylinder, means to introduce a combustible charge into the cylinder behind the piston, means to introduce a charge of air into the cylinder in front of the piston, means to ignite the combustible charge, and means including tubing extending between opposite ends of the cylinder to transmit some of the heat of combustion to the charge of air when said air has been compressed by the piston.

1,258,769. TORCH. John Harris, Cleveland, Ohio.

1,258,835. PUMP. George Washington, Ann Arbor, Mich.

1,258,855. FLUID-OPERATED PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,258,864. AIR STARTING-GEAR FOR COMBUSTION-ENGINES. Alfred Buchi, Winterthur, Switzerland.

1,258,892. METAL-BENDING MACHINE. Alvah M. Griffin, Kansas City, Mo.

1,258,912. APPARATUS FOR MIXING FINELY-DIVIDED MATERIAL AND AIR. Alonzo G. Kinyon and Arthur I. Jacobs, Chicago, Ill.

1,258,998-9. DRILL-SHARPENER. Jesse Ditson, Littleton, Colo.

1,259,045. DRILL - SHARPENER. Theodore H. Proske and Alexander L. Proske, Denver, Colo.

1,259,118. AIR-COUPLING. Homer L. McFarland, Conway, Mo.

1,259,201. BOAT. Worth R. Barringer, Grand Junction, Colo.

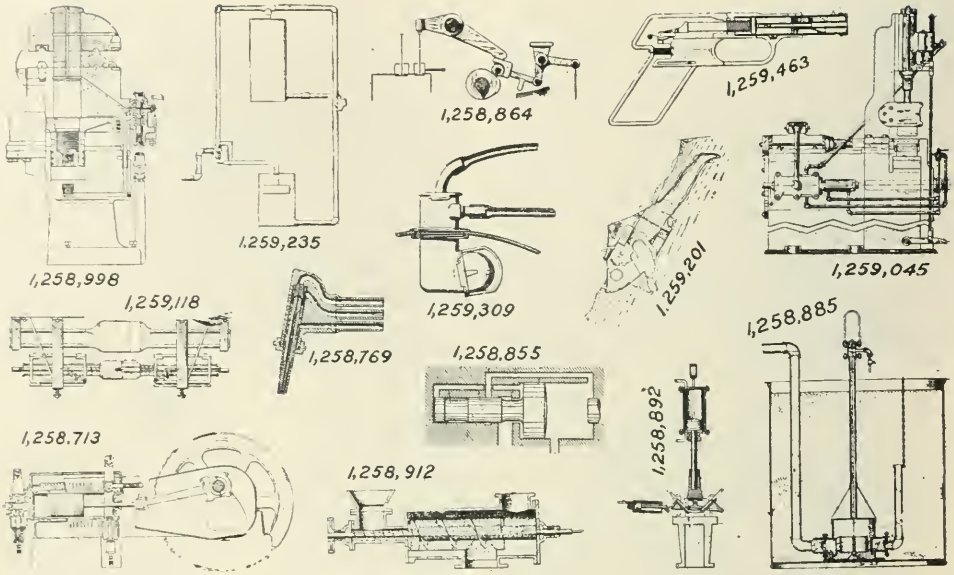
3. A vessel of the character described including a body portion open at one end and having means to support a body of a person therein, a closure plate for the open end of said body, flexible leg receiving envelops secured to said plate, a propeller for the vessel, a compressed air operated motor operatively connected to the propeller, said body being provided with an engine compartment, and a gas engine therein also operatively connected to the propeller.

1,259,235. VACUUM-REGULATOR FOR OIL-PUMPS. James W. Hobbs, Burkburnett, Tex.

1,259,291. AUXILIARY AIR-VALVE. Brainard G. Rich, Colville, Wash.

1,259,309. MILKING-MACHINE. Charles E. Somers, Milwaukee, Wis.

1,259,317. AUTOMATIC AIR - INSPIRATOR. Henry A. W. Thomasson, South Bellingham, Wash.



Pneumatic Patents March 12

1,259,409. PNEUMATIC HAMMER. Hugh F. Jones, John E. Lane, and Edward M. Lillie, Ray, Ariz.

1,259,463. AIR-GUN. Jesse De Fir, Paragould, Ark.

MARCH 19

1,259,537. MINING SULPHUR. Anthony F. Lucas and Godfrey M. S. Tait, Washington, D. C.

1,259,593. AIR-COMPRESSOR. Henry J. Bery, Detroit, Mich.

1,259,622. PNEUMATIC SHEET-LIFTING DEVICE FOR AUTOMATIC SHEET-FEEDERS OF PRINTING-MACHINES. Heinrich Heenss, Berne, Switzerland.

1,259,737. FLUID-PRESSURE BRAKE SYSTEM. James A. Hicks, Atlanta, Ga.

1,259,805. COMBINED AIR INLET AND EXHAUST VALVE. Reason C. Tharp, Osceola, Mo.

1,259,809. LIFE-BUOY. Albert Atwood Unruh, Portland, Oreg.

1,259,883. MOLDING-MACHINE. Wilfred Lewis, Haverford, Pa.

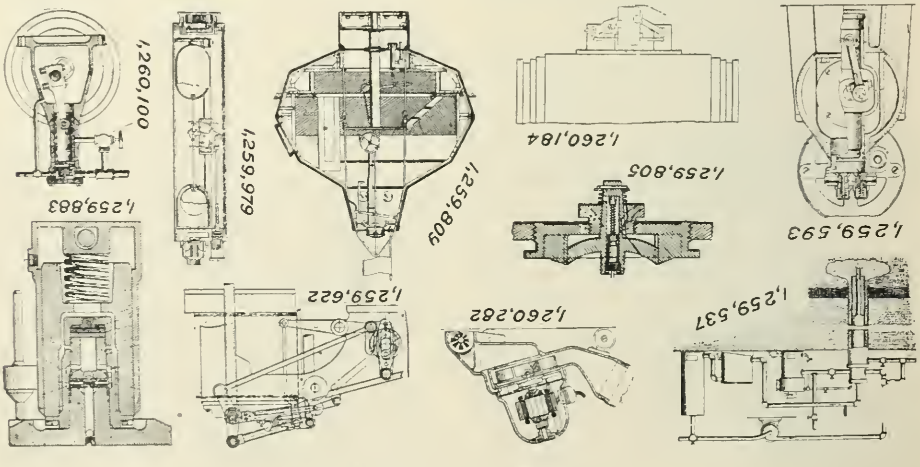
1,259,979. HYDROPNEUMATIC PUMP. Benjamin Samuel Hampton Harris, Greenville, S. C.

1,260,100. GAS-COMPRESSOR. Louis N. Udell, Chicago, Ill.

1,260,101. AIR-BREAK COUPLING. Oren J. Vickers, Gasparilla, Fla.

1,260,184. FLUID-OPERATED VALVE MECHANISM. John C. Glenn, Erie, Pa.

1,260,282. MEANS FOR AIR-COOLING MOTORS. Harmon H. Harrold, New Philadelphia, Ohio.



Pneumatic Patents March 19

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

Vol. xxiii JUNE, 1918 No. 6

VENTILATING THE BIG HIGHWAY TUNNEL

The proposed highway tunnel to be built under the Hudson from Jersey City to New York, the design and method of construction of which were shown in Compressed Air Magazine for May, involves another and most serious problem, that of ventilation. This, except in a small way, is a new but very imperative requirement. The principal vehicles to use the tunnel would be gasoline driven motor cars, and the noxious gases from these if not systematically and very completely taken care of, would render traffic impossible.

Instructive experience in this direction has been had in the London tunnels. In the Rotherhithe tunnel on one typical day, the average traffic between 8 a. m. and 8 p. m. included 104 motor vehicles and on another day 186. Even with this comparatively small motor traffic it was found that the ventilation was distinctly bad and it was quite evident that, with the increase in motor vehicles, artificial ventilation will shortly have to be provided. On certain days the air in the tunnels is reasonably fresh, while on others, with equal traffic, it is very bad, depending upon the direction of the wind, and upon atmospheric conditions.

The land sections between the open ends and the first shafts are short and generally well ventilated, as fresh air enters the open ends and blows out at the first shaft. The inner sections, failing to get fresh air in any quantity from the entrances, depend upon the ventilating shafts to exhaust the bad air, which is then replaced by partially vitiated air from the outer sections. Ordinarily, the air in these sections, while unpleasant to breathe and trying to the eyes, is not so thick that it interferes in any way with traffic, but on days of great humidity the air in the inner sections is so heavy with smoke and vapor that it is impossible to see an approaching vehicle one hundred feet away. Tunnel employes work continuously in this atmosphere with no apparent ill effects.

The fact that there have been no serious prostrations, notwithstanding the passage of as many as 84 motor vehicles per hour through 1,200 ft. of practically unventilated tunnel, indicates that, with proper artificial ventilation, a much larger number of motor vehicles can pass in safety.

EXPECTED TRAFFIC IN THE BIG TUNNEL.

In the case of the proposed Hudson River tunnel it is estimated that the motor traffic per day will be not less than 4,250 motors in 1920, 6,870 in 1925 and 10,100 in 1930. It is also necessary to consider that on days when navigation on the river is impeded by fog, ice, or other adverse conditions, all of the motor vehicles in the district now served by the five downtown ferries would seek the tunnel and that, therefore, ventilation and other facilities should be provided for not less than 10,000 motors per day, with the possibility of increasing the facilities so as to provide against double that number.

AN EXPERIMENTAL TUNNEL SECTION

One of the first steps taken, therefore, in the development of the project was to conduct a series of experiments to see whether it was feasible to take care of the fumes arising in the tunnel, especially on account of its great length of about 3,724 ft. between the two pierhead lines. These experiments were made under the auspices of the Public Service Corporation of New Jersey on its property at Passaic Wharf, in Newark.

An air-tight building was constructed 125 ft. long, as a model of a section of the proposed tunnel, with roadways, sidewalks, etc., complete, including air ducts with openings into the top and bottom of the tunnel, and electrically-operated blowers and exhaust fans of proportionate size.

The tunnel section was filled with gasoline motor trucks and automobiles of various sizes, to the number of eight in all, and a series of tests was made under the direction of Dr. Gellert Alleman, of Swarthmore College. Samples of air taken at many points in the tunnel, with all the cars running, throttled down and racing, with and without ventilation, were analyzed. Tests were made with fresh air introduced at the top and exhausted at the bottom and similar tests with the direction of the air reversed. The volume and velocity of the air so introduced was measured, and a chemical analysis made of the air samples taken during these tests.

Figs. 1 and 2, reprinted from Heating and Ventilating Magazine, show the arrangement of the section as tested.

CONCLUSIONS OF TESTS

From the analytical results obtained Dr. Alleman draws the following conclusions:

1. When all doors and ventilators are closed and the engines of eight cars are racing for thirty minutes, the atmosphere becomes intolerable; the high content of unsaturated hydro carbons ("smoke") being responsible for a marked irritation of the eyes and respiratory organs, and the carbon monoxide producing distressing physiological disturbances. Such an atmosphere must be regarded as dangerous to persons who breathe it for a continuous period of fifteen minutes.

2. When all doors and ventilators are closed and the engines of eight cars are "running light" for thirty minutes, there is a marked improvement in the condition of the atmosphere as indicated under Test 2, but the breathing of such an atmosphere for a continuous period of fifteen minutes must also be regarded as dangerous.

3. When all doors are closed and the ventilators are open and exhausting from the top of the tunnel, with the engines of eight cars racing for thirty minutes, there is a further improvement in the condition of the atmosphere over that indicated under Test 1 and Test 2. However, the carbon monoxide content of this atmosphere must be looked upon as probably dangerous either to those persons who are physiologically weak, or to those persons who are particularly susceptible to this gas and who breathe it for a continuous period of thirty minutes.

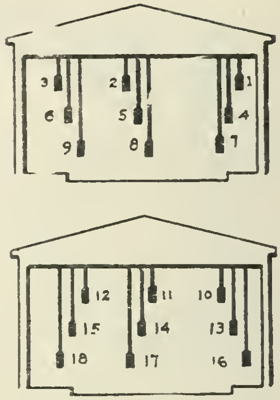


FIG. 1. LOCATION OF PIPETTES

4. When all doors are closed and the ventilators are open and exhausting from the top of the tunnel, with the engines of eight cars "running light" for forty minutes, the condition of the atmosphere is almost normal and the carbon monoxide content is not dangerous.

This conclusion is further supported by the fact that the eighteen persons who remained in the tunnel during this test, for a continuous period of forty minutes, experienced no unpleasant sensations from breathing this air and no subsequent distress.

5. When all doors are closed and the ventilators are open and exhausting from the bottom of the tunnel, with the engines of eight cars all racing for thirty minutes, the condition of the atmosphere is much worse than in Test 3, where the same conditions prevailed, except that the exhaust was made from the top of the tunnel. Such an atmosphere is not only unpleasant, but must be regarded as dangerous if breathed continuously for a period of thirty minutes.

6 When all doors are closed and the ventilators are open and exhausting from the bottom of the tunnel, with the engines of eight cars all running light for thirty minutes, there is only a slight improvement in the condition of the atmosphere over that indicated in Test 5. Moreover, the condition of this atmosphere is much worse than the air in Test 4, when the same conditions prevailed, except that the exhaust was made from the top of the tunnel. Such an atmosphere is unpleasant and must be

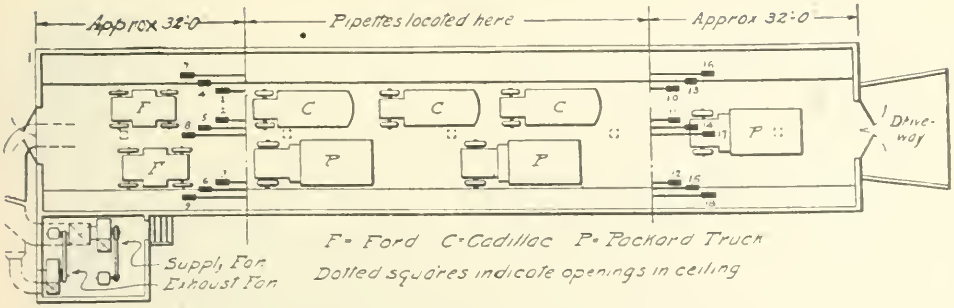

Approx 32'-0
Pipettes located here
Approx 32'-0
Driveway
F = Ford C = Cadillac P = Packard Truck
Dotted squares indicate openings in ceiling
Supply Fan
Exhaust Fan
F
C
P

FIG. 2. PLAN OF EXPERIMENTAL TUNNEL SECTION

regarded as dangerous if breathed continuously for a period of 30 min.

7. It appears that the direction of the exhaust air is of considerable importance, the most satisfactory results being obtained when the air enters the tunnel at the bottom and is withdrawn at the top. This was to be expected because of the fact that the exhaust gases leave the motors at a high temperature and are consequently lighter than air, and rapidly diffuse upward. The lateral propulsion of these heated gases into the atmosphere produces a motion which mixes the exhaust gases with the air, thus accounting for the fairly uniform distribution of the products of combustion in the atmosphere of the various parts of the tunnel.

8. Some of the odors which are unpleasant are in no sense dangerous and are produced by the "cracking" of lubricating oil.

These tests prove that the general method of ventilation outlined for the tunnel is entirely feasible, and that the products of gasoline combustion and smoke can be overcome by the introduction of air in the quantities specified and exhausted as described, leaving the air practically normal.

MODIFICATION OF VENTILATING SYSTEM

The system of ventilation shown in the plan (Fig. 3), in which the exhaust air is drawn out from the two roadways through grating in the pavement, is only tentative. There is no question that this system would be effective with sufficient capacity provided in the exhaust fans. Subsequent studies of the question, however, show that the method is uneconomical and it is likely that the system that will finally be adopted will force the air from the shafts at the bulkhead lines into the tunnel to the center, at which point effective means will be provided for exhausting the air through large ducts back to the shafts.

It is probable that toward the middle of the tunnel there would be additional intake and exhaust facilities.

Forty-five air changes per hour in the tunnel is the minimum quantity at present under consideration, which, it is estimated, would give an entirely satisfactory diffusion of CO and CO_2. In fact, such a quantity of air, the designers state, would give substantially open-air conditions, with an assumed traffic of three lines of motor trucks every 60 ft. moving 10 miles per hour, and using the worst proportion of gasoline and air for combustion.

It is recommended that ventilation shafts be constructed at the bulkheads on each side of the river, where they would offer the least obstruction. The semi-circular arch approach tunnels would be ventilated through specially designed electric light posts, the bottom part of which would consist of cylinders of sufficient diameter to afford the necessary capacity for the intake and exhaust blowers, which would be situated in the arches above the roadways at proper intervals.

It is contemplated that the intake blowers would discharge the fresh air at the top of the roadways2 of the tunnel and into the semi-circular spaces where the blowers are situated. The exhaust blowers would be connected to a separate system of

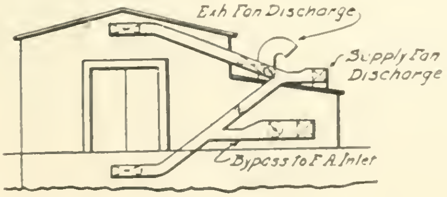


FIG. 3. ARRANGEMENT OF DUCTS

ducts under the pavements, each for a given length of roadway, discharging the foul air through the light posts sufficiently above the level of the streets to obviate any nuisance therefrom.

COMPRESSOR EXPERIENCES WITH SUBMARINE DIESEL ENGINES

By Lieut. F. C. Sherman, U. S. N.*

Diesel engine air-compressor troubles comprise valve trouble, cooler leaks and explosions. They are due to the high temperatures created when the air is compressed in two or more stages from atmospheric pressure to approximately 1000 lb. per sq. in. In the type of engine mentioned at the beginning of this paper, the compressor was designed to take its suction from the scavenger-air housing, and it was then compressed in two stages in tandem to 800 lb. to 1000 lb. per sq. in. This air was cooled from each stage in a cooler consisting of nests of small, straight tubes around which circulated cooling water. The air from the second-stage cooler passes to the spray-air bottle which acts as a reservoir on the way to the spray-air line of the engine. It will be seen that when the two-stage air compressor takes its suction from the scavenger housing containing air at 7 lb. pressure (above atmosphere) it virtually makes a three-stage compressor. On our engine, however, there was always so much oil in the scavenger housing that it was considered dangerous to compress air containing so much oil and subject it to the temperatures reached, and in practice it gave considerable trouble. So the suction to the scavenger housing was disconnected and a suction direct to the atmosphere substituted which gave a straight two-stage compression from athospheric pressure to 1000 lb. per sq. in. This worked much more satisfactorily as regards presence of oily vapor in the compressed air and occurrence of cooler explosions.

A common practice in Diesel-engine design seems to be to have a restriction in the spray-air line between the reservoir and the engine. The only object of this, that I have been able to discover, is to enable a higher pressure to be carried in the reservoir than is needed on the spray-air system, so as to build up a reserve for starting after the engine has been shut down. If this is its purpose, it never was successful for us, and only resulted in reducing the amount of spray air we were able to get through to the fuel valves. Furthermore, it would frequently clog up and catch dirt and oil to further reduce the opening, so that in general it was more of a nuisance than anything else. Acting on this belief, the restriction on the spray air was removed entirely and much better results in every way were obtained. Whereas before, poor fuel combustion had been obtained when carrying 800 lb. to 900 lb. pressure on the spray air, after removing the restriction perfect combustion was obtained with as low as 550 lb. to 600 lb. pressure on the spray air.

USING NO OIL FOR LUBRICATION

Another point in regard to air-compressor trouble is cylinder lubrication. The principal danger is too much lubrication, allowing oil to be carried into the compressed air and causing high temperatures or explosions from burning or combustion of the oil vapor. The best practice is to eliminate direct cylinder lubrication entirely and depend on the moisture and oily vapor in the engine-room atmosphere to furnish sufficient lubrication. In practice this worked very well for us, and we had no trouble from lubrication while using no oil whatsoever directly on the air compressors.

VALVE TROUBLES

The principal valve trouble which we experienced was due to the valve springs losing their temper after a few hours' running, due to the high temperatures of the uncooled air to which they were subjected. The second-stage suction valve was the principal source of trouble, and when its spring gave out it would leak, allowing second-stage pressure to back up in the first-stage receiver and increase the work on the first stage and in general raise hob. Another source of valve trouble was the gradual collection of carbon deposits on the valve seats due to the presence of oil in the air and causing the valves to leak.

WATER INSTEAD OF OIL

Cutting off the oil used for cylinder lubrication helped both troubles. But the greatest assistance to correct these faults was a water cup installed on the first-stage air suction and set to feed a small quantity of fresh water into the compressor with the air. This water cup was simply a large oil cup arranged for drop

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*Journal American Society of Naval Engineers.

COMPRESSED AIR PAINTING A WOODEN SHIP

feed, filled with fresh water instead of oil. A fairly rapid feed was set on it, about two to four drops per second, and this water was dropped through the top of the air-suction pipe and drawn into the compressor with the air. The action of this fresh water was found to be as follows. It helped to lubricate the valves and cylinder walls and prevented the deposit of carbon. The high temperature almost immediately turned it into steam, absorbing some of the heat without rise of temperature in the form of latent heat, and thus keeping down the temperatures developed due to compression. In addition the steam kept the carbon from collecting and gumming up the valves, and the reduced temperatures resulting prevented the springs from losing their temper. This fresh-water cup was a fine thing, and I strongly advise other Diesel-engine operators to try it on their air compressors.

THE METHANEPHONE

This is a little instrument recently perfected by a young Welsh professor in London for the protection of mine-workers. It consists of a small wooden box about 9 inches high containing an electric battery. At the top of the box is a fuse head cap upon which a tiny light always glows from the battery beneath. As soon as a certain low percentage of methane gas enters the workings its presence causes a tiny explosion in the fuse head, the explosion in turn melting a fine wire filament, which starts a bell to ringing continuously. The men in the vicinity are thus notified that gas has made its appearance and can take the necessary precautions. Officials of the Miners' Federation of Great Britain have witnessed effective tests of the methanephone.

TESTING AN AIR COMPRESSOR

By Walter S. Weeks*

When a compressor is sold it is guaranteed to have a certain volumetric efficiency by orifice test.

This efficiency is determined as follows: The air delivered per minute by the compressor is measured. The volume of this air is calculated under the conditions that prevailed at the intake of the compressor. This volume is divided by the volume swept per minute by the piston of the low-pressure cylinder. The result is the efficiency sought. The piston rod should be neglected.

The term volumetric efficiency is also used in comparing the performance of a compressor at different altitudes and with different intake temperatures. This use of the term is in my opinion unnecessary and confusing. The whole subject may be clarified by using the term 'volumetric efficiency' only for that given by the orifice test and stating the air-consumption of tools in subic feet of compressed air at a given gage-pressure.

An example, if I may digress for a moment, would be something like this: An air-drill requires 10 cu. ft. of compressed air at 90-lb. gage. The altitude is 10,000 ft. The temperature of the mine is 100°F. The temperature of the compressor-room is 60°F. What must be the displacement of the low-pressure cylinder to run 10 drills? The volumetric efficiency of the compressor by orifice test is 80%.

Compressed air needed $10 \times 10 = 100$ cu. ft.

Ratio of compression at 10,000 ft. $= \dfrac{90+10}{10} = 10$

Free air needed $= 10 \times 100 = 1000$ cu. ft.

1000 cu. ft. is needed in the mine at 100°F. It is 60° in the compressor-room, so the free air at the temperature at the compressor-room is $\dfrac{520}{560} \times 1000 = 929$. The compressor will deliver, at this altitude, according to the maker, only 80% of the piston-displacement, hence the displacement needed is $\dfrac{929}{0.8} = 1161$ cu. ft.

The vital questions about an air-compressor are: How much does the compressed air cost, and is the compressor doing all that it should?

To answer these questions we must measure our power input, we must measure the air delivered, we must take indicator-cards on the air end, and determine the displacement.

The measurement of power on the driving side is familiar to all, but a rapid way of measuring the air may not be quite so familiar. The air is best measured by what is known as the low-pressure orifice method (Fig. 1). All the compressed air that the compressor will make is discharged from the receiver through a valve *a* into a tank *b* in which is placed a nozzle or orifice *c*. The valve is closed until the compressor will just hold the receiver pressure desired. The pressure just back of the nozzle is taken with a water manometer *d*, and its temperature is taken with a thermometer *e*. From these data, with the size of the nozzle, the air flowing per minute may be computed.

The flow through an orific is assumed to be adiabatic, but an adiabatic formula is cumbersome. If we assume that the density of the air is a mean between the density inside and outside the tank, a simple formula can be developed from the basic principle that $V = \sqrt{2gH}$. This simple formula agrees with the adiabatic formula up to 18 in. of water. A discussion of the development of the simple formula may be found in 'Engineering Thermodynamics,' by C. E. Lucke.

The formula there given is pounds of air per second through a circle of

$$d \text{ in. diam.} = 0.01366\, d^2 \sqrt{\frac{h_w P}{T}}$$

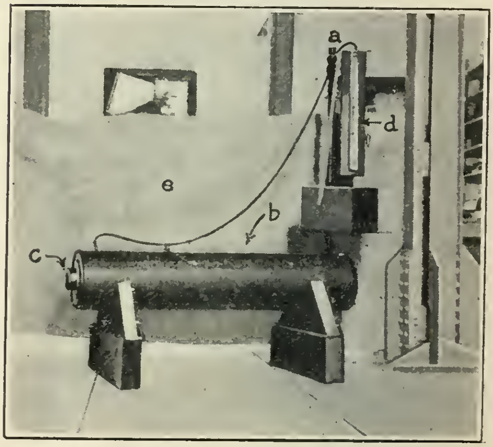

FIG. 1

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*Associate Professor of Mining, University of California.

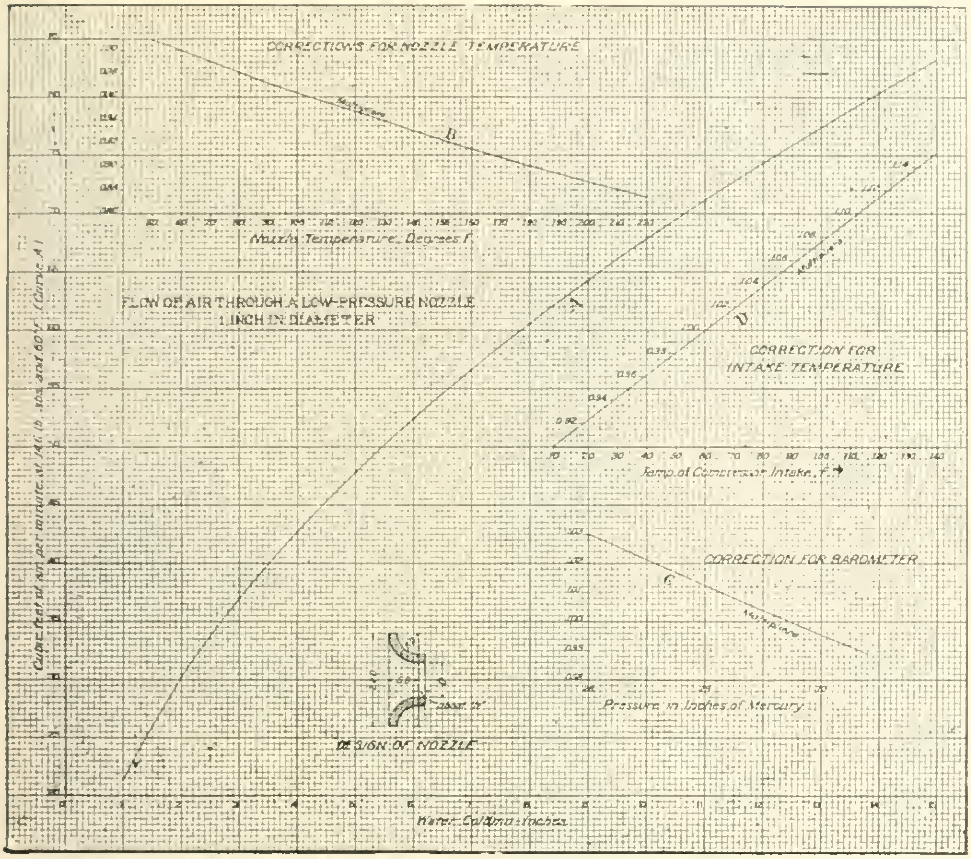


FIG. 2

d=diam. of nozzle in inches.

h_w=difference in pressure on the two sides of the nozzle in inches of water (never over 18 in.).

P=mean pressure on the two sides of nozzle in lb. per sq. ft.

T=absolute temperature back of the nozzle in degrees F.

What we are after is the cubic feet of free air delivered per minute under intake conditions. Curves may be plotted to make our computations easy.

To find the weight per minute multiply by 60

$$W = 0.81960\, d^2 \sqrt{\frac{h_w P}{T}}$$

First assume the nozzle to be 1 in. diam., the nozzle temperature 60 F., the barometric pressure 14.6 lb. per sq. in., and determine the weight that will flow out per minute with water-gages from 1 to 15 inches.

After these weights are determined, calculate the volumes under a standard set of conditions by the formula

$$V = \frac{w R T}{P}$$

V=volume in cu. ft.

w=weight in lb.

R=53.34.

T=absolute temperature=520 F.

Ps=absolute pressure in lb. per sq. ft.=14.6 ×144=2102.4.

We now have the data for curve A (Fig. 2). The values plotted include a coefficient of flow for the nozzle of 0.98, which from various investigations appears to be reasonable.

Now suppose the nozzle temperature instead of being 520° abs. is some other temperature T_1 abs. We can determine the flow by multiplying the values on curve A by $\sqrt{\frac{520}{T_1}}$. The measured at 60°F. This correction is plotted in curve B. ....

Now suppose the barometric pressure is not 14.6 but some other pressure P_1 lb. per sq. in. In formula No. 1 P is the average pressure in lb. per sq. ft. Let Pm_1 be the average pressure in the same units when P_1 is the barometric pressure. The flow of air when the barometer is P_1 may be obtained by multiplying values air after making this correction will still be from curve A by $\sqrt{\frac{Pm_1}{P}}$

Without appreciable error we may use the ratio of barometric pressures instead of the average pressures. So we way multiply by $\sqrt{\frac{P_1}{14.6}}$ instead of $\sqrt{\frac{Pm_1}{P}}$

After making this correction the air would still be measured at 14.6 lb. per square inch. We want the volume at pressure P_1 so we must multiply by $\frac{14.6}{P_1}$; thus the total correction will be $\frac{14.6}{P_1} \times \sqrt{\frac{P_1}{14.6}} = \sqrt{\frac{14.6}{P_1}}$

This correction forms the basis for curve C. I have used inches of mercury for the barometer pressure because most aneroid barometers read this way.

After making the corrections for nozzle temperature and barometer we have the air at 60°F. and at the barometric pressure existing. There remains still to compute the volume at the intake temperature. This correction is merely the ratio of the absolute temperatures and is plotted in curve D.

The final result must be multiplied by the square of the diameter of the nozzle in inches.

Example of the use of the chart:

Nozzle 2 in. diam.

Water column 8 in.

Nozzle temperature 80°F.

Barometer 30 in.

Intake temperature 90°F.

Curve A 60.6 cu. ft. at 14.6 lb. per sq. in. and 60°F.

Curve B, 0.981.

Curve C, 0.995

Curve D, 1.058.

Square of diam., 4.

Total correction, $0.981 \times 0.995 \times 1.058 \times 4 = 4.131$.

$4.131 \times 60.6 = 250.34$.

The nozzle then is discharging each minute 250.34 cu. ft. air at 90°F. and 30 in. of mercury. This figure divided by the displacement gives the volumetric efficiency.

Let us suppose that we are testing a two-stage compressor driven by a belt-connected induction-motor.

An indicating wattmeter gives the power-input.

The air-cylinders should be fitted with indicators.

Tests should be run at various gage-pressures. Let us suppose we are running a test at 90-lb. gage.

All gages should be calibrated. Discharge all the air that the compressor makes through the nozzle and adjust the valve to the tank till a pressure of 90 lb. is maintained in the receiver. Let the compressor run under these conditions for 15 minutes. Read wattmeter, water column, nozzle temperature, intake temperature, barometer, r.p.m., and take indicator-cards.

The horse-power calculated from the indicator-cards divided by the horse-power input gives the over-all mechanical efficiency.

From the cost of power, the kilowatt input, and the air delivered, may be calculated the cost of compressed air per unit.

The air delivered divided by the displacement of the low-pressure cylinder gives the volumetric efficieny.

With the aid of the low-pressure indicator-card we can determine the slippage.

The actual volume of air taken in each stroke at atmospheric pressure is represented by the length of the atmospheric line included in the indicator diagram. Glancing at Fig. 3: if AB represents a displacement volume K then the volume of air taken in each stroke at atmospheric pressure is $\frac{CD}{AB} \times K = L$.

Less air is taken into the crank end of the cylinder than into the head end because the piston-rod takes up room; therefore the displacement of each end must be figured separately

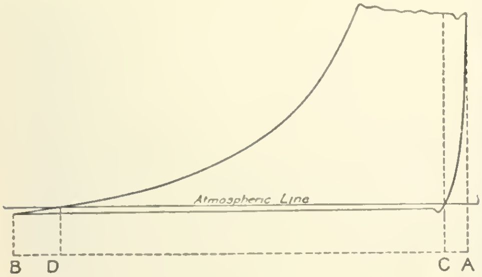


FIG. 3

Let L_1=volume at head end at atmospheric pressure.

Let L_2=volume at crank end at atmospheric pressure.

Let S=r.p.m.

Then the number of cubic feet of air that actually enters the compressor each minute at atmospheric pressure is $(L_1+L_2)S=M$.

The air delivered as measured by the nozzle divided by M gives what is called the slippage efficiency. It is assumed that the air is not heated on its way into the compressor. The air must be warmed somewhat, just how much in a fast-running compressor, I don't know. A little study will show that the warming of the air will make this efficiency appear lower than it really is. Even if the method is not rigidly accurate, it will detect leakage by the piston and through the valve.

S. B. Redfield, testing engineer for the Ingersoll-Rand Co., to whom I am indebted for much information, has used a similar chart for many years in testing the many compressors turned out by the plant, and has found the method most satisfactory. On the chart is a sketch of the nozzle adopted by Mr. Redfield. Fig. 4 is a photograph of a nozzle. A casting should be made of brass and the nozzle threaded to screw into the tank. The nozzle should be polished. For a test a nozzle should be selected to keep the water gage less than 15 inches.

The area of the tank should be twenty times the area of the nozzle. An even flow through the tank is desired. The globe valve admitting air to the tank may be made delicate by fastening a long lever to the handle. When a compressor is purchased, specification should be made that it be tapped for indicators. These holes are handy in testing the tightness of valves and pistons.

It would be an excellent idea if the makers of air-compressors would agree on a standard method of testing. As the case stands at present a comparison of guarantees is impossible because the compressors are tested by different methods. The important guarantee of a compressor is the horse-power input per 100 cu. ft. air delivered. The way that the air is measured should be carefully scrutinized.

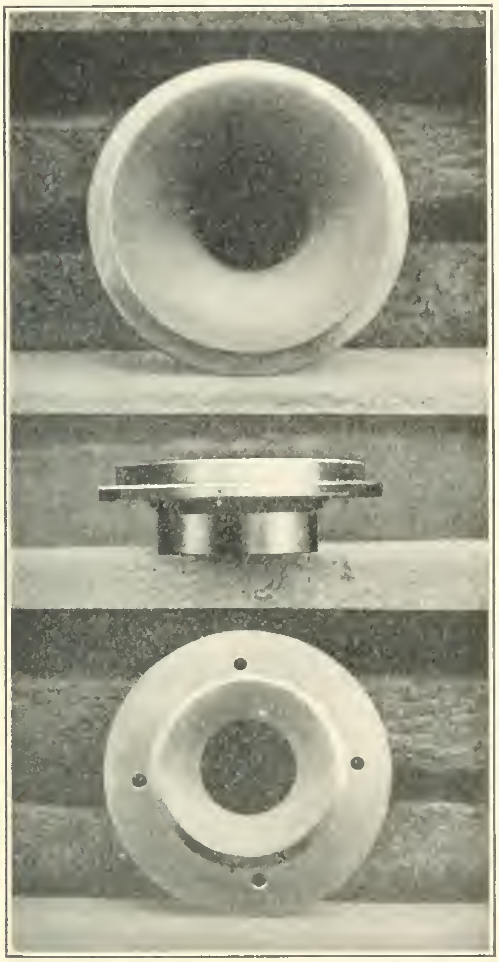


FIG. 4

In order that curve A may be plotted to a more open scale, I append the values from which it is plotted.

Water-col. in inches	Cu. ft. of air	Water-col. in inches	Cu. ft. of air
1	21.32	9	64.28
2	30.17	10	67.79
3	36.97	11	71.15

4	42.72	12	74.36
5	47.79	13	77.44
6	52.39	14	80.41
7	56.62	15	83.28
8	60.57		

—*Mining & Scientific Press.*

THE INVERTED DEPTHS OF THE ATMOSPHERE

The sensational German feat of dropping shells on Paris has awakened a great deal of interest in the nature of the air through which the shell plows its way on its 120-mile course; for while the actual range of the gun is in the neighborhood of 75 miles, assuming that the gun is elevated to an angle of 43½ degrees, the shell must rise to an altitude of about 24 miles above the earth. We do not know much about the condition of the atmosphere above an altitude of 7 miles except by theoretical reasoning. The maximum elevation ever reached by man is probably that attained by Glaisher and Coxwell on September 5, 1862. Mr. Glaisher made his last observation when his balloon had carried him up 29,000 feet. He was then ascending at the rate of 1,000 feet per minute. Shortly after that he lost consciousness and Mr. Coxwell, his assistant, also began to lose the use of his muscles. However, he succeeded in stopping further ascent by pulling the valve cord with his teeth, as his arms were powerless. Thirteen minutes later Mr. Glaisher regained consciousness and then found that his balloon was descending at the rate of 2,000 feet per minute; from which he estimated that, in the interval, they must have reached the extreme altitude of over 36,000 feet. In 1901 the German balloon Preussen reached an altitude of 35,100 feet. These are the highest altitudes ever reached by man, and they are not one-third of the altitude that must be reached by the shells fired from the Forest of St. Gobain.

Judging from the curve of pressures recorded in the lower strata of the atmosphere it is assumed that there is a very high vacuum at that height. Of course, this does not mark the limit of the earth's atmosphere. Meteorites come shooting down to the earth with velocities up to 20 miles per second leaving a trail of fire caused by the friction with the air or with gases surrounding the earth. These trails have been observed as high as 200 miles, but it is probable that at a height of 24 miles there is so little air that the sky loses its blue appearance, because there is hardly enough of it to produce the refraction of light which gives it its luminosity. And so, if we could accompany this shell on its course, we should probably find the sky growing darker and darker, until it became nearly black. In the black sky the sun would show as a ball of fire, while the stars which were not obliterated from view by glare of the sun's light, would also be visible. Below us we should have the reflection of sunlight from the earth and from the denser strata of the atmosphere.—*Scientific American.*

THE LADY CONTRACTOR

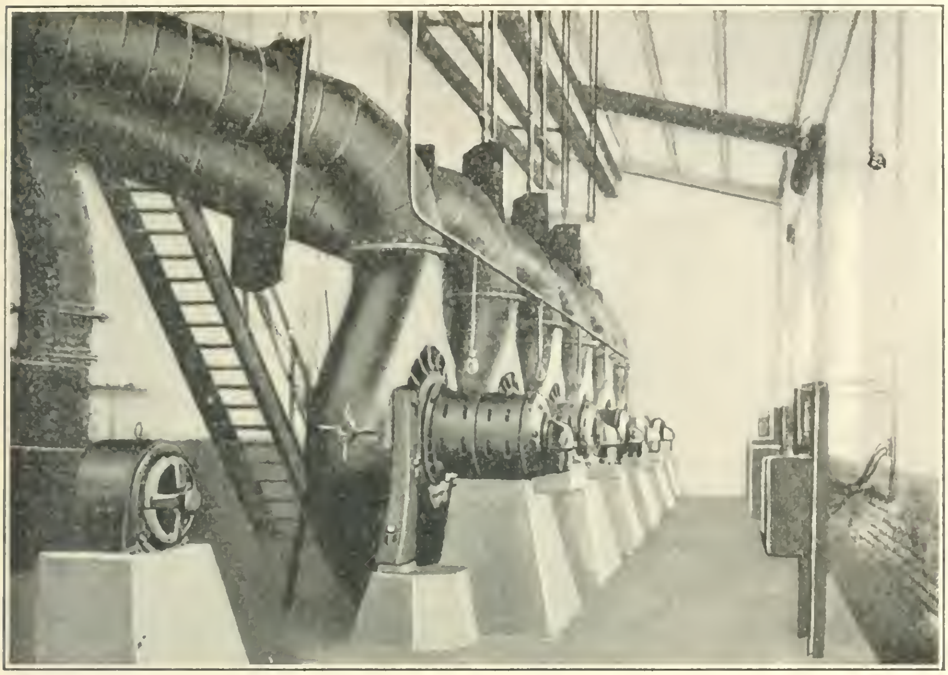
You see, F. H. Davis, a young contractor living in Fresno County, California, secured a $59,000 road contract. A few days later after starting work he received a letter summoning him to a training camp. Davis, anxious and determined to serve his country, was distressed by the prospect of being forced to abandon his road contract. The perplexity of his problem was suddenly lifted by the inspiration of his wife, who ventured the suggestion that she could learn to operate the big White five-ton truck and Austin road machinery and carry the contract to a successful finish.

Hazel climbed into hubby's overalls and onto the truck. Davis showed her how to operate the different levers and, after a few days' coaching, she proved her ability to handle the machinery and boss the job.

Hazel's crew was, at first, inclined to loaf on the job and take advantage of the "woman boss." But she does not countenance "slackers."

While her husband is being turned into a first-class fighting man Hazel is carrying on the work and has received the first payment on the contract—a check for $10,000.

Davis isn't the contractor's real name—but the story is based on real facts taken from the experience of a contractor who really was drafted and whose wife came to the front just as "Hazel" did in this movie, which is being produced by the National League for Women's Service, to show woman's usefulness in the war. So while the lady contractor is not yet an everyday sight, except in the film world, she's on the way—*The Contractor.*



THE LARGEST BLOWER INSTALLATION FOR PULVERIZED FUEL

SAVING OUR NATIONAL RESOURCES BY USING PULVERIZED FUEL

Attention is specifically called in this article to the extent of the use of pulverized fuel in the industries, and its helpful warlike possibilities. The half tone above, here reproduced from General Electric Review, May, 1918, shows a line of seven electric driven centrifugal air compressors or blowers installed at the Washoe Smelter of the Anaconda Copper Mining Company, Anaconda, Montana. These machines are of 10,200 cu. ft. capacity each, and furnish the air for blowing pulverized coal into reverberating copper smelting furnaces. They collectively deliver over 70,000 cu. ft. of air per min. at a gage pressure of 1 lb. per sq. in., drawing in considerable additional air by induction. This plant is at an altitude of 5,000 ft. above sea level and is the largest pulverized coal installation in existence, although another installation of six similar units is underway at the new smelting plant of the United Verde Copper Company, Clarkdale, Arizona.

The above illustration accompanies a valuable article by Mr. F. P. Coffin, of the Research Laboratory of the General Electric Company, summarizing the advantages of pulverized fuel and the reach of its adaptability, what follows being a brief abstract of the article spoken of.

GENERAL ADVANTAGES.

1. Flexibility of control of both fuel and air, and ability to extinguish instantly.

2. Complete combustion, even at high rates of burning, and elmination of smoke.

3. Burning fuel in suspension eliminates the usual troubles resulting from the formation of clinkers.

4. Low-grade fuels may be burned efficiently regardless of the proportions of ash, sulphur or other impurities.

5. Very little excess air is required, which reduces the slack loss and the power required, and also the areas of flues and stacks.

6. Maximum fuel economy is made possible in many applications.

7. The expense of supplying coal to scattered industrial furnaces is reduced to a minimum. Pulverized fuel has semifluid properties; it flows easily and can be transferred through pipes:

a. By screw conveyors.

b. In a mass by means of compressed air.

c. In suspension in a current of air.

IN INDUSTRIAL FURNACES.

Pulverized coal was first utilized in the United States about twenty-six years ago, for economically burning cement rock in the rotary kilns of the Portland cement industry. It has now largely replaced more expensive fuels such as oil, in parts of the country where coal is readily obtainable. The rotary cement kiln fired with pulverized coal has been applied in several other industries, as for calcining various minerals.

DRYING.

Pulverized coal is used for drying cement rock before feeding it to the kilns, and it has been used to a small extent for firing rotary coal dryers in pulverizing plants. One plant is installing equipment for drying bauxite in a rotary kiln. In the fertilizing industry it is used for drying tankage (garbage and sewage), for drying and slightly roasting phosphate rock, and for drying feldspar shale in rotary kilns for use as fertilizer filler.

METALLURGICAL FURNACES.

The most important application in which pulverized coal has made notable progress in the last few years is in the metallurgical field. Marked economies have been attained by the application of this fuel to furnaces used in the manufacture of iron, steel, copper, zinc, galvanized iron, and tin plate.

The application of pulverized coal in the metallurgical industries is still in its infancy, but the list of plants using it shows that it has made good progress.

The shortage of natural gas in some localities has been an incentive for the greater use of pulverized coal, and the high cost of fuel oil has been an additional incentive.

On the average, the substitution of pulverized coal as a fuel for metallurgical furnaces has resulted in a saving of about 33 per cent of the fuel required when burning coal in other ways.

One feature of interest in this connection is a comparison of the percentage of excess air required when burning various fuels in metallurgical work.

Pulverized Coal	5 to 25 per cent
Hand-fired coal......	100 to 125 per cent
Stoker-fired coal	50 to 100 per cent
Producer gas	50 to 75 per cent
Natural gas	40 to 50 per cent
Fuel oil	50 per cent and upward

The field of steam generation may be subdivided into three classes: stationary boilers, locomotives and steamships.

STATIONARY BOILERS

The high efficiency attainable with modern mechanical stokers has rendered the introduction of pulverized fuel for boiler firing less attractive, at first sight, than in the case of industrial furnaces. The development of the underfeed stoker has forestalled pulverized fuel in this field so that the latter has a more difficult field to travel. Pulverized coal may be regarded as the ideal fuel, but the additional machinery required is a handicap.

LOCOMOTIVES.

On locomotives hand firing still persists owing to the difficulty of making satisfactory stokers to operate within the limited space available. The steaming capacity of large locomotives is often seriously limited by the inability of the fireman to shovel coal fast enough to maintain full steam pressure, and by the continual opening of the fire door which disturbs uniform draught. In the western states, where only poor grades of coal are available, this difficulty with hand firing has often led to the substitution of oil-burning engines on mountain grades. In this service it is difficult to burn oil efficiently when forcing the boilers. Pulverized coal has the same advantages as fuel oil in locomotive service in regard to stoking and, in addition, efficient combustion can be maintained at high rates of burning.

Pulverized fuel is already being used on a commercial scale on locomotives in two foreign countries. The Central Railway of Brazil has twelve locomotives operating with Brazilian coal and American equipment. This coal has such a high sulphur content that it has not been successfully burned in any other way. Brazil has always imported its coal heretofore, although enormous deposits of native coal are available. Additional locomotives are now being equipped.

One line of the Swedish government railways, 60 miles in length, is being operated with locomotives burning peat powder. This is burned in suspension in the combustion air similarly to pulverized coal. The development work was carried on by the Swedish government with a view to replacing imported coal.

STEAMSHIPS.

Fuel oil has made considerable headway in displacing coal, both in the merchant marine and in the navies of several countries, in spite of its high cost in some parts of the world. Its advantages over hand-fired coal are:

1*m* Saving of stokehold labor.
2 Fuel handling is reduced to the simple operation of pumping oil through pipes. This applies both to oiling the ship and to feeding the burners from tanks located in any part of the vessel.
3 Cleanliness.
4 Low fireroom temperature.
5 Higher calorific value.
6 Higher efficiency in boiler firing.
7 Ability to operate boilers at a higher rating.
8*m* Ability to force boilers instantly when an attack demands a sudden increase of speed.
9*m* Smokeless combustion.
10*m* Ability to work up a smoke screen instantly by overfeeding fuel.

The four advantages marked (*m*) are of especial military value. By establishing pulverizing plants at ports, coaling stations, or on board naval colliers, pulverized coal could be used on ships with practically all the listed advantages over hand-fired coal, except (5). More tons of coal must be carried than is the case with oil owing to the high calorific value of oil. However, pulverized coal is burned with better efficiency than hand-fired coal, and this fact will partly offset this disadvantage. Oil is burned on shipboard with at least 12 per cent better efficiency than hand-fired coal, and the same should be true with pulverized coal.

Pulverized coal when stored in strong tanks along the sides of a ship presents considerable possibilities in the way of torpedo protection.* The U. S. Shipping Board has recently authorized the building of a large steamship embodying this idea and using pulverized coal as fuel.

NECESSITY FOR CONSERVATION OF FUEL OIL.

The building of so many oil-burning ships, together with the loss of many oil tankers through the operation of German submarines, raises a serious problem in regard to the supply of fuel oil in adequate quantities.

There is a large source of oil available in Mexico but we must build new tank steamers to transport it. The greater part of Mexico's output has come from two wells. This naturally renders the supply uncertain, for oil wells are subject to accidents or fires; besides which this source of supply is not under our control and is in danger of possible interference.

Oil is such a valuable fuel in our industries that it can only be spared if equally practical and efficient fuels are available as substitutes. It is doubtful if fuel oil can be entirely replaced, except by expensive gaseous fuels. Pulverized coal is the most economical substitute for many purposes and is much cheaper than fuel oil at the present prices.

The further industrial application of pulverized coal should release fuel oil for the use of the great fleet now building for the American merchant marine, and for the navy.

This appears to be the most immediately available method of alleviating the situation, but it will not be adequate to release all the oil that will be required.

PULVERIZED COAL FOR OCEAN TRANSPORTS

It is very evident, therefore, that the most effective method of dealing with this phase of the fuel situation is to immediately attack the problem of utilizing pulverized coal on board ship. Like all new developments, this is a problem in which it will take time to work out details in connection with the initial installations, before it can be applied on a large scale.

Pulverizing stations will have to be established at several of our leading ports. As the greater part of our exports to Europe are shipped from Boston, New York, Philadelphia, Baltimore, and Newport News, it will be sufficient to establish pulverizing stations at these five ports where ships may be coaled for the round trip. Commerce from other ports can be carried in ships burning oil or ordinary coal.

The slight disadvantage of limiting a ship to certain ports may be overcome by installing equipment for burning oil as an emergency fuel to enable the ship to complete a voyage from some other port to her home port. Oil may be carried in the double bottom where it will be independent of the coal storage and handling equipment. The same compartments can be used also for shipping oil to Europe as cargo.

ELECTRIC POWER AND PULVERIZED FUEL.

The article from which we are abstracting

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*Hudson Maxim, *Scientific American*, Mar. 30, 1918.

speaks of the availability of electric power and of its ready adaptability to all the operations involved in connection with the industrial burning of pulverized fuel, but this is all so obvious that it is not necessary to reproduce it here.

THE APPEAL TO THE STEAM TURBINE ENGINEER.

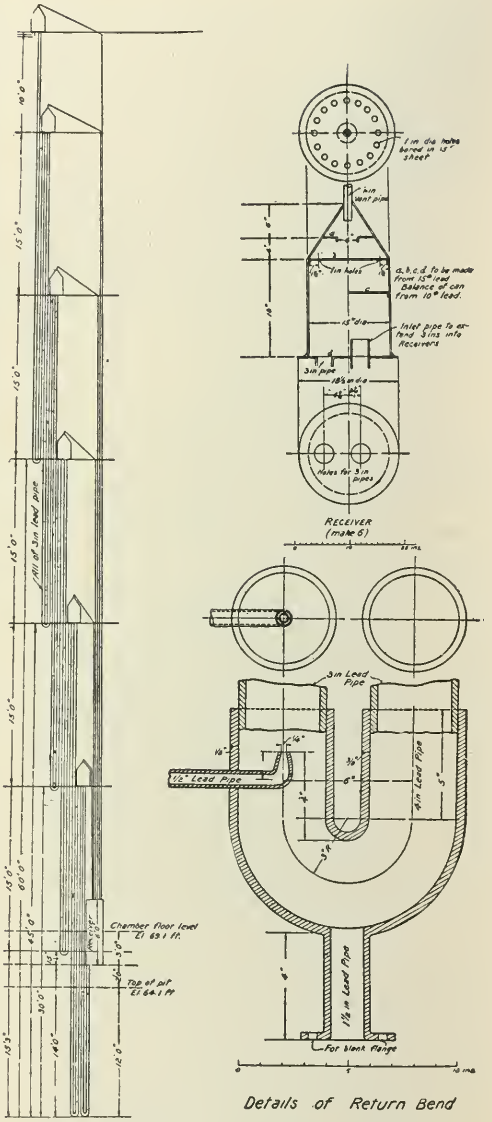
From the point of view of the engineers having to do with the design and development of steam turbines and electrical machinery, it is rather discouraging to see old and wasteful methods of burning fuel persist in the boiler room. They have been gradually bringing the equipment of the generating room up to the highest attainable efficiency by refinements in design and construction. It does not require much in the way of careless firing to nullify their efforts when the overall efficiency of the central station is *the* important consideration in generating electricity from coal.

The underfeed mechanical stoker has much improved the efficiency of the boiler furnace, but it still has its limitations, especially when burning low-grade fuel. With the development of efficient methods of handling and burning pulverized fuel, the power station engineer has another method at his disposal for solving his problems. It may not be universally applicable, in the present state of the art, but it is a great advantage to have two good methods of burning coal under boilers to choose from, each of which has its advantages for certain applications.

The efficient utilization of our low-grade fuels is a matter of ever increasing importance. The re-equipment of old boiler plants for burning pulverized coal may often be more easily accomplished than the installation of efficient stokers, even when good coal is burned.

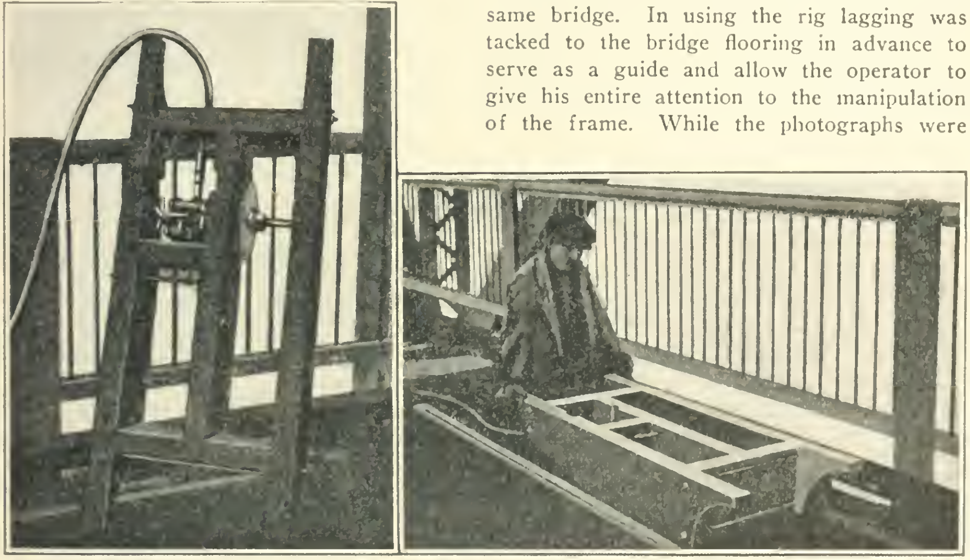
On shipboard, the steam turbine with mechanical or electrical gearing has much improved the steam economy, and the old-time practice of hand firing should be abolished from the stokehold without further recourse to fuel oil, which is an expensive fuel of limited availability.

It is authoritatively stated that the number of airplanes destroyed by the French aviators and the members of the Lafayette escadrille for a period of ten months was 120 over the French lines and 397 over the German lines, all total wrecks.



AIR LIFT IN A SULPHURIC ACID PLANT

An interesting, finely illustrated description of the Calumet & Arizona sulphuric acid plant, Douglas, Arizona, is contained in the March 30 issue of Mining and Scientific Press. Of special interest to our readers is an ingenious application of the air lift there employed for elevating the acid. The operation is shown in detail in the accompanying sketch, the total lift being 90 feet. The acid is lifted in stages through lead pipes, the distance between successive receivers being 15 feet. The compressed air is introduced by a jet, as shown in the detailed drawing, just above the bend of the pipe. The acid flows from the receiver in solid column down the right hand pipe and the levitation accomplished by the air jet carries the acid in the left hand pipe to another receiver 15 feet higher, and so on to the top. The adjustment of the air pressure is controlled by a Davis regulating valve. This device has a pumping capacity of 300 to 500 tons of acid per day.



PORTABLE AIR DRIVEN CIRCULAR SAW

IMPROVISED PORTABLE CIRCULAR SAW

The half-tone above, reproduced from Engineering News-Record, the story accompanying it being told by Charles J. Bennett, State Highway Commissioner, Hartford, Conn., shows how continually new employments of compressed air develop wherever the compressed air habit of thought is cultivated.

Faced with the alternative of removing the guard rail and taking up the entire planking of a bridge 1800 ft. long, the Connecticut Highway Commission devised the special saw rig shown in the illustration, which cut through the first layer of flooring, making it possible to tear up the planking whose replacement was desired without disturbing the part that could still be used.

The saving in labor was considerable and, combined with the greater speed, makes the appliance more than a curiosity.

The circular saw, driven by an air drill, was mounted in an oak cradle of simple construction which was chamfered at one end so that the depth of cut could be regulated by rocking the frame—a simple matter, since the weight of the operator was sufficient. The air drill received its power from a portable gasoline compressor which was being used for some drilling and riveting on the steel work of the same bridge. In using the rig lagging was tacked to the bridge flooring in advance to serve as a guide and allow the operator to give his entire attention to the manipulation of the frame. While the photographs were not taken on the bridge where the rig was used they illustrate the operation perfectly. A. R. Doe, superintendent of bridges, was responsible for the amplification of the suggestion for such a machine.

AIR HAMMERS AND STONE WORKERS

A report by the United States Public Health Service, March 22, 1918, gives in detail the results of a thorough examination of the effects of the use pneumatic tools upon the workers in the Indiana limestone field. The investigations were conducted by J. P. Lake, Passed Assistant Surgeon, and Dr. David L. Edsall, Consultant in Industrial Hygiene, both of the public Health Service.

Dr. Edsall says:

"We requested Mr. Griggs, president of the Journeymen Stonecutters' Association of North America, the local officers of the stonecutters' association, and many of the men in both Bedford and Bloomington to bring to us those who complained most, or we got their addresses and went to their homes. None of the men that we examined were sent to us through the employers, and none were examined in the presence of the employers or their representatives. In Bedford we reached them chiefly in their homes. This had the advantage of making them and their households feel quite free to talk in regard to their condition. In Bloomington, Mr. Walters, the secretary of the local branch of the stonecutters' association, brought the men to us. In both places the men seemed extremely frank and open in what they said. They are, as a class, superior men in personality, education, and manner of living. It rapidly became apparent that because the symptoms that I shall describe occur frequently, and fear had been aroused in various ways that they might grow worse, the anxiety of the men was due more to this fear of further and more serious results than to anything known to have occured. In fact, several of those with the most pronounced manifestations said that if that was all, they thought it of comparatively slight consequence. Their fears of bad results had apparently been largely aroused within two years by their interpretation of the opinion of some physicians who had seen some affected men, but who, so far as we could learn, had not actually studied the cases or the men's work carefully, but had somewhat naturally based their advice upon the men's own apprehensions."

A very careful examination was made of nineteen men and Dr. Edsall says that the principal cause of complaint was a temporary blanching and numbness of the fingers when chilled. It occurs almost entirely when the weather is cold, and chiefly in the morning when the men start work and before they get "warmed up." It also tends to recur in cold weather when they are not working or when they plunge their hands in cold water. The condition was described by the men as "annoying," rather than serious. The numbness does not interfere appreciably with the use of their hands. Occasionally they state that it makes them clumsy, slower and less accurate in their work while it lasts.

The men sometimes complain of lameness in the arms, shoulders, or chest, says Dr. Edsall. Two said they slept badly and twitched and turned in their sleep after working hard with the hammer. These two, however, were in poor general condition. Various other symptoms of vague character and significance were elicited in some of the men. I may, however, for brevity's sake state here that neither questioning the men nor careful physical examination showed evidence that the symptoms mentioned or any others outside those in the hands were of any particular significance. They were rather such symptoms as some members of any group of men will always show when doing work, of whatever kind, that is at times hard work and often carried out in constrained positions.

Some of the men said that the sensation was exceedingly disagreeable to them at first, but all except the nervously over-sensitive soon get so accustomed to it that they pay no attention to it. It is in this respect like many other accompaniments of industry, as for instance the noise in many forms of work.

No muscular atrophy was observable. Five men stated that they had earlier had the trouble decidedly, but that it had gradually lessened until it had almost entirely disappeared. They attribute this to having learned to use the tool with greater skill and especially with an easier and less cramped grip. Other experienced workmen told me the older and more skillful men have less bother than the younger and less skilled and attributed this to the same cause and to the fact that the young men use the mallet little in "roughing out," while the older have more familiarity with the mallet and use it a good deal. Mr. Griggs stated also that it is more common in the young men than in the older. He believed this due to the more common use recently of the larger hammer, but the older men state that they use the larger hammers as much as do the younger.

Dr. Edsall says that there are three chief factors that evidently may play a part in producing the symptoms: Cold, constriction, and vibration. He is inclined to believe that the cold elicits the symptoms, rather than produces them. He makes these recommendations:

"It is obvious that certain simple things may be done to attempt to eliminate the trouble. First of all, the shank of the tool, where it is held, could be made larger, so that the grip need not be so strained. In doing this it would be well to use some substance that would conduct cold or heat poorly, instead of, as at present, intensifying the effect of cold by holding the cold metal. Asbestos suggests itself, and its practicability could be tried. Some of the men have tried rubber hose drawn over the tool, but said it tended to work upward on the tool and choke the action of the hammer. One man, however, said that he soaked the hose in oil, drew it on his tools, and allowed the softened rubber to adhere to the tool in drying and thereby was able to use it successfully. He said that he had earlier had 'dead fingers' but is no longer troubled by them. Asbestos, if practical, would have evident advantages. Some such handle would perhaps serve also to some extent as a shock absorber and thus reduce the possible effects of vibration. It is possible, too, that practicable methods of keeping the tools warm in cold weather could be easily devised and would reduce the discomfort. It is is also to be noted that the practice of controlling the exhaust with the thumb or fingers of the right hand should be discontinued. In the same connection it is to be observed that in some hammers, due either to their construction or to wear, the exhaust leaks out downward along the tool—which it should not do—giving a slight constant blast of cold air on the left hand. This should be obviated. Heating the compressed air has, I believe, been tried, but meets with difficulties, and I do not believe it would be of much value if successfully done.

"Reducing the time spent at any disadvantageous work and shifting to other forms of work is in many kinds of industrial disorders sufficient largely to overcome the trouble. In this instance there is an obvious way of accomplishing this—by requiring the men to use the mallet in suitable parts of the work, especially in 'roughing out.' The operators say they have always preferred that this should be done, especially because compressed air is expensive, but that the men will not do it. The men admit they use the hammer in such work when they do not need to, partly because they get more done, but they say that unless they do the foremen look unfavorably on them and are likely to drop them because they do not work so fast. Evidently adjustments and understandings are needed on both ends here The men and the operators and their foremen should recognize that the frequent shift to the mallet may go far to obviate the trouble. Dr. Lake's conclusions agree thoroughly with those of Dr. Edsall.

WAR CHEMISTRY

By Henry Howard*

Let us not forget the year of delays and many failures that England and America experienced in developing their numerous high explosive plants, while Germany, with its highly developed dye industry, was able almost over night to adapt its dye plants with their skilled labor to the manufacture of high explosives, so similar are the two lines of manufacture.

There is no doubt that a permanent coal tar dye industry is a matter vitally affecting our national safety in times of peace, because in no other manner can the necessary plant and skilled workers, easily and quickly convertible to use in munition manufacture, be kept available for emergency calls in times of need.

After January, 1915, *potash* importations from Germany practically ceased. Our chemical industry has already succeeded in producing a substantial tonnage of American potash, ranging from the low grade material suitable for fertilizers to that of the greatest purity necessary for use in the manufacture of optical glass such as was formerly made in Jena, Germany, for the use of Zeiss glasses. The importance of this glass at the present time for the manufacture of range finders and high power field glasses can hardly be overestimated. Although the crude potash tonnage now produced is far below the imports before the war, yet very substantial progress is being made. The most important deposit is Searles Lake, San Bernardino county, California, which contains brine testing 4 per cent potassium chloride, from which the potash is recovered and purified.

The rapid growth of the American potash industry is shown by the following production figures all calculated on the basis of 100 per cent potash:

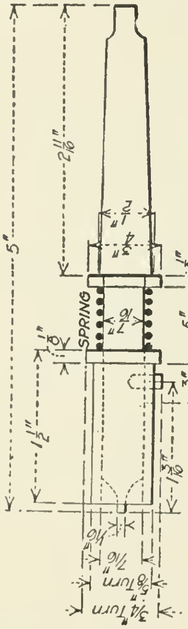
Twelve month, 1915—970 tons.
Twelve months, 1916—9720 tons.
First six months, 1917—14,000 tons.
Second six months, 1917—28,000 tons.

---

*Vice President Merrimac Chemical Company, Boston.

The above figures are from Mr. Hoyt S. Gale, Geological Survey.

At the present time production is probably at the rate of more than 60,000 tons per year, a remarkable showing for an industry only three years old, a result by the way which could not possibly have been attained if price regulation had been practiced in the manner that we have seen in some of our important products. The result is due to almost superhuman efforts of manufacturers to get the benefit of the fabulous prices that potash has been bringing in this market.



AIR-OPERATED SCREWDRIVER

COMPRESSED AIR OPERATED SCREW DRIVER

In the packing of munitions most of the covers are fastened on the boxes by wood screws. The operation of driving in the screws occupies a large portion of the time taken to pack a box, and also considerable strength if done by hand. For some time past we have been using the screw driver shown in the cut. It is made with a Morse taper shank, and is used in a No. 4 "Little David" Canadian Ingersoll-Rand drill. The loosely sliding bushing by the thrust of the spring normally overhangs the screw driver a little and, being slotted on the side, is held from dropping off by the little pin as shown. When a screw is to be driven the bushing drops over the head of the screw and when the screw driver is rotated it finds its own place in the nick. *George M. Dick in American Machinist.*

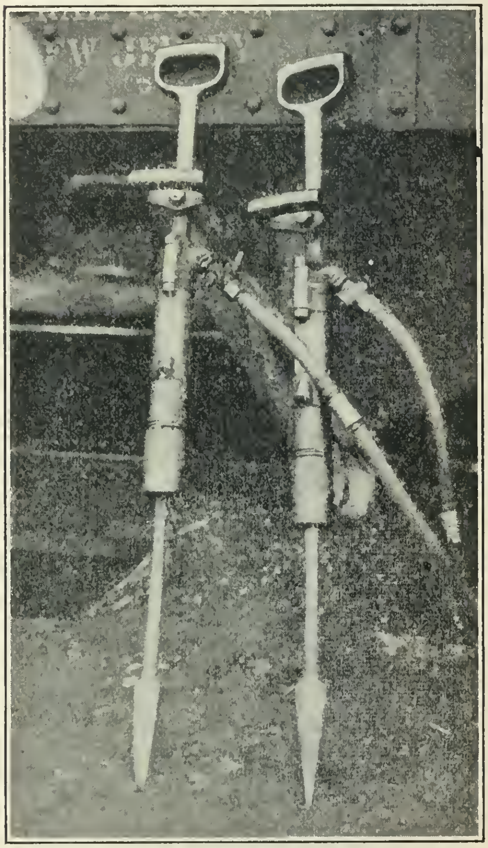


FIG. I

PNEUMATIC TAMPERS LOOSEN FROZEN COAL

By H. L. Hicks

The matter here presented is a little out of season just now, but it may be better to fix it here than to try to keep it over for next season. During the severely cold weather of last winter there developed a novel and interesting adaptation of the pneumatic tie tamper to the breaking up of masses of frozen coal when unloading hopper bottom cars, and excellent results were obtained by this means at coal depots around New York, Chicago and various lake ports when the scheme was introduced. At Chicago the tampers have been applied also

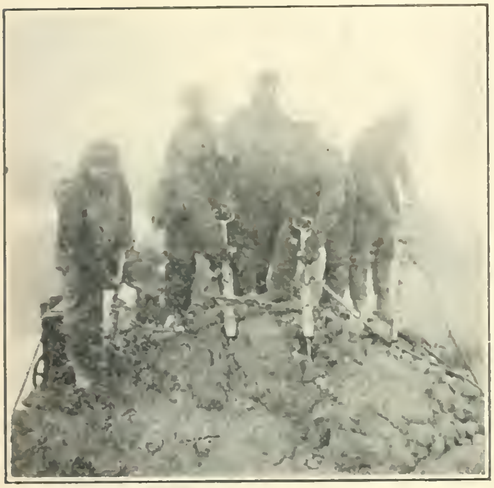


FIG. 2

to picking frozen ore in cars, clearing mill scale from the chutes at steel mills and breaking up frozen scale in gondola cars. At one point the experiment was tried of applying the tamper against the side of a car of soft coal, the vibration thus set up causing the coal to let go and move out of the car with a rush.

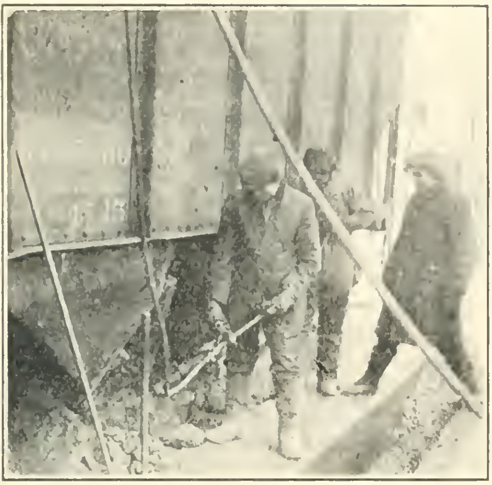


FIG. 4

For this class of work the tamping machines have been fitted with pointed picks, Fig. 1, in place of the usual tamping bars. The tools are light enough to be conveniently handled regardless of the work or its location. Fig. 2 shows the starting and Fig. 3 the last stage in unloading a solidly frozen carload of buckwheat anthracite after the usual steam thawing has been completed. At this coal dock it was found advantageous to station one man outside the car, Fig. 4, to break up the lumps that clogged the chutes. The general opinion was that the tampers were most effective in frozen bituminous and in the smaller sizes of anthracite coal.

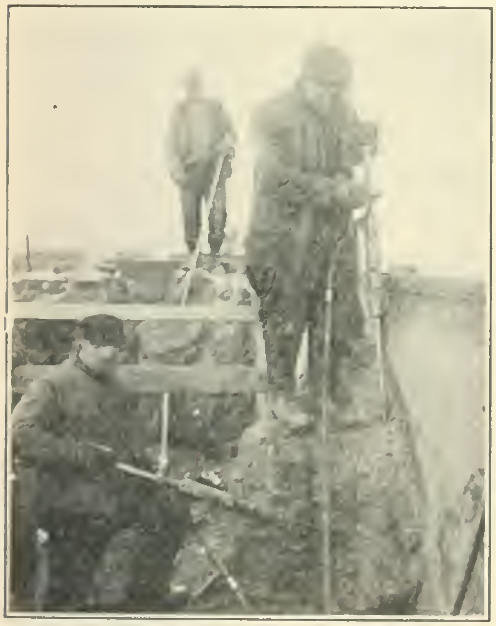


FIG. 3

IMPORTANCE OF BINOCULAR VISION FOR AIRMEN

In speaking recently regarding the medical aspect of flying, Sir Watson Cheyne, the famous English doctor, among other interesting things states: "An important thing is the necessity of having true binocular vision, especially when traveling at a great speed, and of having a very rapid connection between the sight and the action; in fact, in selecting pilots, one of the most important points to ascertain is whether the binocular vision is good, and also the time it takes between the aviator seeing and taking action. Very often it has been discovered that one eye is not used at all. Many people are going about with one eye and are not using the binocular vision; that is an extremely dangerous thing. You could not allow a man to enter the Air Service unless you found he had proper binocular vision.

DETAILS OF GAS WARFARE

By S. J. M. Auld*

Not so much is heard of gas warfare at the present time as two years ago, when the first use of that method of attack was made on the Western Front. Gas is, however, used to a tremendous extent, and the amount that has been and is being hurled back and forth in shells and clouds is almost unbelievable. The success of a cloud gas attack depends on thorough preparation beforehand. The attackers must know the country, the layout of the trenches, and the direction and velocity of the wind with certainty. Favorable conditions are limited practically to wind velocities between twelve and fourteen miles per hour, with no upward currents. German gas attacks are made by two regiments of Pioneers, with highly technical officers, including engineers, meteorologists, and chemists.

The first attack was made with chlorine. If a gas attack is to be made with gas clouds, the number of gases available is limited. The gas must be easily compressible, easily made in large quantities, and should be considerably heavier than air. If to this is added the necessity of its being very toxic and of low chemical reactivity, the choice is practically reduced to two gases—chlorine and phosgene. The gas is contained in an ordinary cylinder like that used for oxygen or hydrogen. Pure chlorine did not satisfy quite all the requirements, as it is very active chemically and, therefore, easily absorbed. Pads soaked in solutions of sodium carbonate and thiosulphate were first used in the protective respirators. Later, with the introduction of phosgene, a gas which is very insidious and difficult to protect against sodium phenate was used.

There are so many conditions that have to be fulfilled in connection with the gas cloud that its use is limited. The case is different with gas shells. The gas shells are the most important of all methods of using gas on the Western Front, and are still in course of development. The first use of this method was with the celebrated "tear" shells. A concentration of one part in a million of some of these lachrymators makes the eyes water severely. The original tear shells contained almost pure xylyl bromide or benzyl bromide, made by brominating the higher fractions of coal-tar distillates. Another substance used in shells which simultaneously harasses and seriously injures is dichloro-diethylsulfide (mustard gas). It has no immediate effect on the eyes beyond a slight irritation. After several hours the eyes begin to swell and inflame and practically blister, causing intense pain, the nose discharges freely, and severe coughing and even vomiting ensue. The Germans have also used phenyl-carbilamine chloride, a lachrymator, and diphenychlorarsine, or "sneezing gas." The latter is mixed with high explosive shells or with other gas shells, or with shrapnel. It was intended to make a man sneeze so violently that he is unable to wear his mask. The sneezing gas has, however, not been a very great success.

Up to the present time there has been no material brought out on either side that can be depended upon to penetrate the respirator. The casualties are due to surprise or to lack of training in the use of masks. The mask must be put on and adjusted within six seconds, which requires a considerable amount of preliminary training if it is to be done under field conditions. Both sides are trying to find something the others have not used, and both are trying to find a "colorless, odorless, and invisible" gas that is highly poisonous. It is within the realm of possibility that the war will be finished literally in the chemical laboratory.

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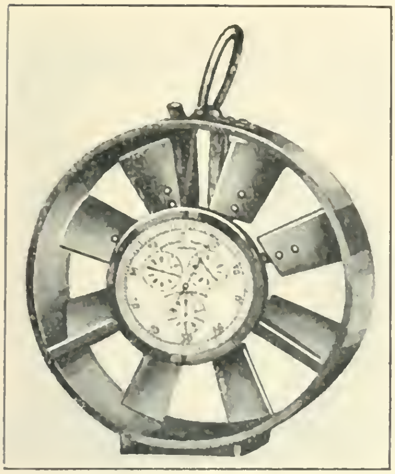
*Journal of the Washington Academy of Sciences.

MEASURING AIR VELOCITIES IN MINES

The measurement of the quantity of air passing in a mine airway, by taking velocity readings at a given point in the airway is attended with numerous difficulties that render the results obtained more or less approximate. There are many conditions that make it practically impossible to determine accurately what is the average velocity of the air current in a mine airway.

As is well know, a straight airway that is unobstructed, permitting a uniform flow of air through it, will not give the same velocity readings in close proximity to the sides, top and bottom of the airway as at the center. The friction between the passing air and the rubbing surface of the airway acts to retard the flow of the air in contact with that surface.



BIRAM ANOMOMETER

Again, where bends occur much of the air is deflected from its course in the airway, and crowds the outer curve of the bend where the velocity will be the greatest. Owing to the same cause, the velocity at the inner curve of the bend will be less than at any other point of the airway.

Again, because of a difference in temperature or gaseous condition of the air passing into the mine and that filling the workings and many void and abandoned places, the warmer or lighter air will crowd the roof of the airway, while the cooler or heavier air travels along the floor. This may give a different velocity of the air current at the roof and the floor. The same effect is observed in dips and rises in the airway, where the bulk of the air may crowd the roof or the floor of the passage as the case may be.

An important factor to be considered, in taking measurements of the velocity of air in an airway, is the obstruction that the observer's body presents to the even flow of the air. It is impossible to make any accurate allowance for this obstruction, which always acts to increase the reading of velocity, but not in proportion to the decrease in sectional area by reason of the observer's body.

Not infrequently has it happened that a crafty mine foreman, knowing that his mine was short of air, would affect to be much interested in the readings taken by the mine inspector, hoping that the inspector would not realize that his presence in the airway would give a higher reading, which was his real intent and purpose.

Notwithstanding these practical conditions that affect the accuracy of velocity readings in airways, the prevailing practice is to measure the volume of air passing by taking anemometer readings at a selected point in the airway, where the sectional area has been carefully measured, using for that purpose the Biram anemometer shown in the accompanying figure. In my opinion, the chief point to be considered is that these readings should always be taken at the same point in the airway and under similar conditions, so that the comparison of the readings taken from time to time will be of greater value than if these readings has been taken at different points and under varying conditions.

When taking the velocity readings the observer should stand facing a rib of the airway, with his back against or near the opposite rib. He should hold the anemometer at arm's length, say a foot or so beyond the center of the airway. It is well to take a one-minute reading, say 2 ft. above the bottom and another like reading 2 or 3 ft. below the roof. We would suggest that an attempt to obtain an average reading by moving the anemometer about in the airway, except under particularly favorable conditions, is not generally satisfactory.

While the readings of the anomometer, taken with proper care, are generally accepted in the measurement of air volumes, in common mining practice, when greater accuracy is required engineers employ a Pitot tube, which is an instrument designed to measure the velocity of air in a conduit, as determined by the pressure head producing such velocity. This instrument is not adapted to general use in mines, however, and requires more skill than average mining men possess.—*Coal Age*.

Best results so far obtained in prime movers are a horsepower-hour for 14,000 B.t.u. in large steam turbines, for 10,600 B.t.u. in gas engines, and for 7,700 B.t.u. in Deisel engines.

It has been experimentally determined in England, where illuminating gas is used as motive power for motor buses, that 250 cubic feet of gas is equivalent to one gallon of gasoline.

SAVE AIR

THE SHIPS that you are
BUILDING are
LIFEBOATS for these
MEN and it takes
950,000 RIVETS
TO BUILD a ship like the
KATRINA LUCKENBACH
AND in the meantime, the
U-BOATS are getting about
3 TIMES AS MANY SHIPS
AS are being **LAUNCHED;**
AND it takes
575,000 RIVETS to build one
DESTROYER to catch a
U-BOAT:
NOW it takes a
MIGHTY SMALL LEAK
TO WASTE enough air
TO RUN A HAMMER
AND WHILE the air
IS LEAKING away, and the
MEN are being **SENT HOME**
FOR WANT of **AIR**, and
LOSING their **PAY**; the
SHIPS are **DELAYED** and
OUR BOYS OVER THERE
ARE IN DANGER; and
THE U-BOATS never
KNOCK OFF a minute.
DO YOUR PART
STOP THE LEAKS
PUT a **WASHER** in your
HOSE; take back the
BUSTED HOSE;
MAKE FULL PAY
EVERY WEEK;
FINISH THE SHIPS and
SERVE YOUR COUNTRY.

Poster prepared by direction of Supt. Benson, of the hull construction department, Fore River Shipbuilding Company. It is to be noted that the ratio of ships built to ships sunk has been much improved since the poster was prepared.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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THE PNEUMATIC PACEMAKER IN SHIPBUILDING

We need not to be reminded that the most urgent task now pressing so heavily upon the industries of the nation is the building of ships for the transport of troops, munitions and food for the Allies, of whom we are one. The world situation is desperate, and probably our help must determine the result—which is far from suggesting any doubt as to what the result will be. Our millions of men and our vast and various supplies avail nothing on this side of the Atlantic. Differences of speed in the output of ships at this juncture may mean—must mean—the saving or the losing of hundreds of thousands of lives, of billions of material values and months or years more or less of the ghastly struggle.

When striving for speed records a pacemaker is often employed, but in the ship-building race the pacemaker is developing automatically. A pacemaker may work either at the front or at the rear, or, we might say, he may either pull or push. The one goes ahead and challenges the pack to outstrip or at least to keep up with him, but quite as effective pacemaking may often be done, as in this case, at the rear. The slow moving units which happen to be indispensable determine the ultimate advance, and the urging of them along is what tells. In the modern building of ships, as we all know, the most constantly responsible single operation is the riveting. Individual ships now under construction will each require from half a million to far above a million rivets, and the entire work of building can go along to completion no faster than the "driving" of these rivets will permit.

It is gratifying to know that a lively rivalry is current throughout the shipbuilding plants on both sides of the Atlantic for the making of riveting records, these being taken, of course, as indices and guarantees of shipbuilding speed.

It is evident enough that lively riveting, such as now evidently is being done, must make all hands hustle to keep up, and perhaps no better pacemaker could be devised. It is a curious thing that we hear of the pneumatic riveter again as exercising its pacemaking function in the production of the boilers for the ships, the output of the boilershops being determined by the speed of the riveters and caulkers just as much as that of the shipyards. In the building of the wooden ships the pneumatic tool, the borer, the pin driver, etc., and especially the caulker shows up again as the pacemaker which has done much to hurry up the work.

The pneumatic tools in American shops and yards are doing their bit, in many more ways than here suggested, just as truly as the guns in France.

USING AIR BRAKES WITH JUDGMENT

The matter of coasting, or of running down grades on the surface railways without the use of power has been investigated and found to afford opportunities for quite important savings. The habits of applying and shutting off the motor current, and of using the brake in connection at the precise times to secure the best results, vary considerably with the individual motormen and consequently the consumption of power for trip varies correspondingly.

In a recent issue of the B. R. T. Monthly, William Siebert, superintendent of surface transportation, points out that the schedules on the Brooklyn Rapid Transit system call for 33,400 trips per day. If each motorman on each trip would coast an additional 250 ft., or less than one-twentieth of a mile, or the normal distance between two numbered streets, it would mean a daily saving in power consumed equal to the power it would take to operate one car 8,350,000 ft., or 1581 miles, and from five to ten times this amount could be easily saved.

A very different appreciation of the coasting effect worked out a score of years ago on the Amsterdam Avenue line, Manhattan, running up to Fort George. This line was at that time operating by cable, and there are several quite steep ups and down on the surface. When the cars were running down hill if the grip on the cable was maintained a considerable forward pull was given to the cable and much power was saved. The motormen in this case were very fond of coasting and they would release the grip and check the speed when necessary by using the brake. Not only was much power thus lost but the cars ran ahead of their schedule time, so that it was necessary to issue stringent orders prohibiting coasting.

NAVAL CONSULTING BOARD ON PULVERIZED FUEL

The following is a brief abstract of a report to the President of the U. S. Shipping Board prepared by the Fuel and Fuel Handling Committee of the Naval Consulting Board:

The art of pulverizing and burning coal as a powder has passed beyond the experimental stage in several of the arts. It is extensively employed for smelting, for burning cement and for generating steam.

From evidence placed before us pulverized coal is a smokeless fuel, a fact of considerable military importance.

By a simple and immediate adjustment of the burners, powdered coal as a fuel may be made to emit dense clouds of smoke to serve as a screen, another fact of military importance.

In an emergency the ship's boilers may be rapidly forced, thereby increasing the steam supply and the speed of the vessel. This is a fact of military importance.

A great reduction in the fire-room force is effected over using solid coal. This saving in man power has military value.

The supply of fuel oil in the United States is limited, and as a means of conserving fuel oil for naval vessels equipped to burn oil exclusively the Consulting Board feels justified in encouraging the use of powdered coal as a fuel for merchant ships, and we therefore earnestly recommend that the Emergency Fleet Corporation authorize the preparation of the necessary plans and drawings for such an installation upon such ships, and that a shore installation be made of such equipment to determine as well as may be the value of such an installation on board ship. Such shore installation can be set up and tested at the Annapolis Experiment Station, Annapolis.

A ship equipped with pulverizing equipment should, in the opinion of the Naval Consulting Board, be expected to take on coal in any port of any kind available and by the ordinary methods. In Atlantic ports this will be run-of-mine bituminous of high volatile and of high grade, sometimes dry and dusty and at other times quite wet.

Such coal on board ship, following shore practice, would then pass through the following processes:

Crushing in power rolls, and delivering to a storage bin.

Drying if found essential to remove the moisture prior to pulverizing, delivering to a second storage bin.

Extraction of iron particles. This being advised to save damage to the pulverizing mill. A magnetic separator is commonly used for this purpose.

Pulverizing, either in Fuller or Raymond mills or their equivalent, then storing in a third storage bin.

Mixing with air, feeding to furnace and burning.

After delivery of the raw coal to crushers the fuel will be handled by conveyors or spouts. All storage bins, conveyors and spouts must be constructed and maintained dust-tight as a means of preventing explosions, and possibly such may have to be made of non-corrosive material.

The Naval Consulting Board is at your service, and if it be your pleasure to proceed in the preparation of designs, estimates and specifications, we shall be honored by your seeking our aid in the solution of this important problem.

NEW BOOK

Powdered Coal as a Fuel by C. F. Herington, New York, D. Van Nostrand Company, 220 pages, 6 by 9 inches, 84 illustrations. $3.00 (net).

To day when powered fuel is being used so extensively for economical and other reasons, and when so many are seeking information upon the subject, this book comes opportunely. What it purposes to do is done in a business way and with satisfactory completeness. The principles involved and the conditions essential to success are discussed and then a large portion of the book is given up to descriptions in great variety of actual installations with full details, costs, etc. A bibliography of 12 pages will be of value to those who wish to know all that is available on the subject.

REPAIRING TUNNEL LININGS WITH GUNITE

The linings of two tunnels on the Northern Pacific which had become seriously disintegrated through the combined action of water, locomotive gases and frost, were repaired recently by giving them a coating of "gunite," a cement mortar, applied by means of the cement gun. Owing to the fact that the entire replacement of these linings would have been both expensive and dangerous, the success of the plan adopted, which necessitated the application of only a relatively thin coating over the old lining, is of special interest. Because of dense traffic and bad atmospheric conditions in one of the tunnels, the work was done under rather trying circumstances.

The tunnels in question are the Bozeman tunnel, located about half-way between Livingston, Mont., and Bozeman, and the Mullan tunnel, about 20 miles west of Helena, Mont., the former at the summit of the Gallatin range and the latter at the summit of the Continental divide. The former presented the most seriour difficulties and is treated in greater detail in the following description:

The Bozeman tunnel is 3,650 ft. long, built for single track, and was lined some 20 years ago with brick and concrete. About six years ago the approaches from both the east and the west were reconstructed to reduce the grade to 1.8 per cent. compensated, these grades extending into the tunnel at both ends to a summit located about 900 ft. from the west portal. Double track was extended up the hill to the portals at the same time.

Both approach grades are operated with helper engines, and as the maximum grade extends into the tunnel, the pushers must follow the trains through in each direction, dropping back after the train passes the summit. This operating arrangement, coupled with the location of the summit within the portals, results in the continual presence of dense smoke. The tunnel is very wet, enough water flowing out of the east portal to supply a water station at Muir, located a sufficient distance down the grade to permit a gravity flow into the roadside tank. This water, coming through the lining and subject to the action of the flue gases and the frost in winter, resulted in the disintegration of both the brick work and and the concrete, the latter suffering the worst. At one time 200 weep holes were installed at various points in the tunnel to concentrate the flow and reduce the seepage through the lining, but this did not reduce the progress of disintegration materially.

Similar conditions obtained at the Mullan tunnel, which is 3,900 ft long and is lined with a brick arch and concrete side walls. The disintegration in this tunnel, however, was not so severe. The summit of the grade line is outside the tunnel, and because of this and the fact that a ventilating plant is in operation, the atmospheric conditions within the tunnel are much better.

After a study of the situation at both of these points a contract was awarded to the Cement Gun Construction Company, Chicago, to repair the linings with an application of gunite. The contractor was paid on a quantity basis, determined by place measurements, the engineer in charge determining the extent and thickness of the coating to be applied from an inspection of the condition of the lining and observation of the results secured as the coating of gunite was applied. This coating was put on to a thickness of 1½ to 5 in. No attempt was made to fill the deeper holes, some of which had a total depth of over one foot. Wherever the lining appeared to be in good condition the coating was omitted. Usually in cases where portions of the first course of brick had disappeared no repair work was done wherever investigations showed that the course underneath was in good condition.

The contractor furnished the plant, labor and superintendent. The railway supplied the materials and the work-train service. The plant consisted of a box car containing a gas engine, belt-connected to a 10-in. by 12-in. single-cylinder air compressor, which supplied air to a cement gun machine placed in an adjacent car, which also contained the materials for making the cement mortar. The roofs of these cars were used as platforms on which the men worked while cleaning the surface of the lining, attaching the reinforcement or applying the stream of gunite. The mixture in the cement gun was transmitted to the nozzle through a 1¾-in. hose. The nozzle was of 1-in. caliber and was also attached to a ¾-in. hose supplying water for washing. It was necessary to operate the air compressor at a rate that compressed about 125 to 130 cu. ft. of free air per minute, in order to maintain the necessary pressure of 30 lb. per sq. in. at the nozzle.

The crew for operating the plant for one shift consisted of one engineer for the compressor, one man operating the cement gun, two or three men mixing the materials, one man feeding the gun, one nozzle operator and one nozzle helper. The materials consisted of cement and sand, the latter secured from Logan, Mont., and being required to pass a ⅜-in. screen. The sand and cement were mixed in the proportions of 1 to 3½, or 9 sacks of cement to 30 cu. ft. of sand. The cement used in the Bozeman tunnel totaled 3,700 sacks and that in the Mullan tunnel 3,400 sacks. The mixture of the material remaining in place in the coating is of course much richer than that indicated above because of the rebound of a large portion of the pebbles. This rebound was greater on the brick surface than on the concrete. One sack of cement on an average covered an area of 2¾ to 3 sq. yd. to a thickness of 1 in.

Before applying the mortar ½-in. lag screws 4 in. long were set in holes drilled with pneumatic hammers, and No. 28 American Steel & Wire Company triangular mesh was attached to these screws in strips of sufficient length to cover as great a width of the arch as it was desired to coat. In general the gunite was applied to a thickness that was deemed sufficient to stop the leakage. Where large areas were wet it was found possible to apply the material around the edges first, gradually reducing the area until finally the water was closed off. In some cases the installing of additional drain pipes resulted in unwatering portions of the lining so that no protection was required. In a few places near the bottoms of the side walls concrete was applied by hand where it could be done readily rather than to shoot it in place with the gun. In some cases two layers of gunite were applied, but on the whole one coating was found sufficient. In the Mullan tunnel several large holes in the arch were repaired by building form work into the holes against which the gunite was applied, the forms remaining permanently in place. As the new surface was adequately reinforced the eventual decay of the form work was of no concern.

The work on the Mullan tunnel was done first and required five months' time. When this was completed the plant and crew were moved to the Bozeman tunnel. Here the work was hampered both by the density of traffic and by the continual presence of smoke. Counting the pusher movements, there were as many as 65 train movements through the tunnel in 24 hours. The work train operated under No. 19 order and was always under the protection of the staff system in effect between the stations at each portal of the tunnel. Both night and day shifts were employed, but the total number of hours of actual work in the tunnel in each 24 was relatively small because of the short periods that the work train could remain in the tunnel and the long waits between the time. Atmospheric conditions were bad, not only because of the slow escape of the smoke produced by the moving trains, but also because of the presence of the locomotive attached to the work train. The workmen suffered severe discomforts both because of difficulty in breathing and the fact that, with the presence of both water and smoke, they quickly became covered with a black slime. Furthermore, the smoke made it very difficult to illuminate the work, and it was necessary to rely upon bells almost entirely for transmitting signals between the men.

While the work on the Bozeman tunnel was in progress the compressor car caught fire and before this could be extinguished the machinery had been ruined. For the remaining work the air was supplied from a temporary plant rigged up from another compressor operated by a steam engine receiving steam from the work train locomotive. Because of the combination of adverse conditions the work was very trying for the entire force, and progress at times was extremely slow.

The repair of both of the tunnels was under the direction of A. M. Burt, chief engineer maintenance of way, Northern Pacific, and F. J. Taylor, division engineer at Livingston, Montana. A. F. Eckhardt was the superintendent for the contractor.

THE GIBRALTAR TUNNEL

The Gibraltar Tunnel is one of those perennial schemes which periodically exercise the imagination of engineers. It is true that the proposal to construct a tunnel under the Straits of Gibraltar has not cropped up quite so frequently as some other great engineering projects have done, and, in fact, the only occasion on which it has been considered seriously was in 1898, when the French engineer, Berlier, drew up his plans. The idea was at that time, however, regarded as impracticable.

M. Henri Bressler has now endeavored to revive interest in the scheme, and at the last meeting of the session of the French Civil Engineers, he read a paper on the subject. He first of all pointed out what a powerful factor such a tunnel would be in the development of the port of Dakar in particular, and of Spain and Morocco in general. There would be a direct line from Paris to Senegal, and the journey from Paris to St. Louis could be accomplished in three days. If connected up with the great Trans-African Railway, contemplated by the British, it would be possible to travel from London to the Cape in a week, assuming, of course, the existence of the Channel Tunnel, as well as the Gibraltar Tunnel.

The separation of Europe from Africa at this point was due to some terrible cataclysm in a remote geological age. The depth of water is, of course, in some places very great, and the sea bottom is extremely rugged and irregular. However, if the site were carefully chosen, it would not be necessary to go below 840 m. (2755 ft.). The point of departure on the Spanish side would be Tarifa, and on the Morocco side there would be a choice of two points, each of which has its own special advantages. The total length of the tunnel would be about 25 kiloms., and a train travelling at 80 kiloms. (50 miles) would traverse it in 20 minutes.

In estimating the cost of construction, the author starts with the figure of 4415f., which is the average cost per metre of the four principal Alpine tunnels: Arlberg, Mont-Cenis, Gothard and Simplon. Taking this figure as a basis, it is estimated that the cost of a marine tunnel would be a little more than double the cost per metre of the land tunnels above named, say, 10,000f. per metre. Assuming the total length of 25 kiloms., this would mean 250,000,000f., to which must be added a further 110,000,000f. for improvements in the port of Dakar, making a total of 360,000,000f.—*The Engineer.*

BOTTLED LIQUEFIED GAS IN THE TRENCHES

The following from "somewhere in France," appears in the daily papers: What is probably a new German liquefied gas was projected this morning against the Picardy front where American troops are fighting. The gas, in its fluid form, is contained in glass bottles. On bursting they give off some substance from which heavy, white fumes, transparent in texture, continue to arise for five minutes. No detonation was heard as the bottles were hurled through the air and apparently they were thrown by a spring. The gas caused nausea, sneezing and coughing but did not otherwise harm any of the Americans.

NOTES

Frost will penetrate to a greater depth in gravel than in clay when both are saturated with water, for water is a better heat conductor than are the minerals that compose soils. In a New England town last winter frost penetrated to a depth of 6½ ft. in gravel and only 3½ ft. in clay.

Soot burns very slowly in the furnace gases because the oxygen is greatly rarefied, the gases containing only a few per cent. of free oxygen; it burns rapidly in the bomb calorimeter or in mixture with potassium chlorate because it is surrounded with highly concentrated oxygen ready to combine with it.—*Bureau of Mines Bulletin No. 135.*

Louisiana, as might be supposed from its geographical position, receiving, as it does, the delta sedimentation from a great continental drainage basin, possesses a remarkable variety of clays. Almost every sort required in the industrial and decorative arts is to be found in that State. The U. S. Geological Survey has recently issued bulletin 660-E, dealing with these resources.

Fertilizers of all kinds will henceforth be subjected to Government control through the operation of an executive order for licensing the importation, manufacture, storage, and distribution of sulphuric acid, sulphur, phosphate rock, acid phosphate, basic slag, sodium nitrate, ammonium sulphate, cyanimid, calcium nitrate, potash salts, cement dust, blast-furnace dust, wood ashes, and all other fertilizer ingredients.

A round, smooth hole in the side of a granite mountain about nine miles out from Mexico City, is locally known by a term which signifies "Pluto's safety valve." The hole is about nine inches in diameter at the opening, which is polished in a manner which suggests human workmanship. That man had nothing to do with drilling or polishing the hole will be readily surmised when it is known that it has occasionally emitted hot air and smoke for a known period of not less than 300 years.

Obviously, mixing is an important factor in combustion. Merely an excess of air in the furnace is not enough; the air must be supplied as near to the surface of the fuel bed as practicable, and be thoroughly mixed with the combustible matter in order that the combustion may be completed in a short time and a small combustion space made effective.—*Bureau of Mines Bulletin No. 135.*

Fuel Administrator Garfield has authorized a survey to be made to determine the practicability of establishing central generating stations at anthracite mine centers and transmitting electrical energy to industrial centers at New York and other seaboard cities instead of transporting coal. If feasible, the project will be financed by the government.

It is planned to link up this system of transmission lines with all vital centers in addition to New York within a radius of 150 miles. Low grade coals will probably be used.

An item in the Swiss engineering journal, *Schweizerische Bauzeitung*, tells of the breakage of a cylinder head due to an unusual cause, bad lubricating oil. The rear cylinder cover of a 500-hp. uniflow steam engine was forced out during operation but not by waterhammer, the usual cause. The cause of the break was found to be in the bad quality of the cylinder oil (tar oil). The deposit from this very thick oil, which also contained various mechanical impurities, accumulated on the piston and cylinder-head surfaces in a continually thickening crust which finally filled the entire clearance space at the back end of the cylinder and in time began to strike, compressing the substance more and more solidly and finally forcing the cylinder head out.

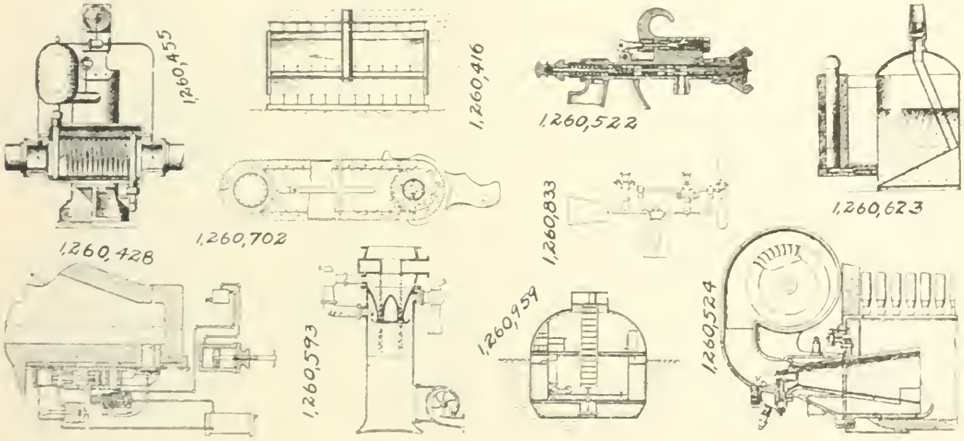
This country has drafted its young men for the greatest sacrifice that a man can make. Is there any logical reason why all able-bodied males should not be compelled to do at least eight hours work every working day until this war ceases, for which they will be paid far beyond what the man who makes the greatest sacrifice is paid? The enemy recognizes no restrictions of labor or time, so that the least that those of us who are at home can do is to stay on the job and put our hearts into it.—*George S. Rice to American Institute of Mining Engineers.*

A new way to make iron or steel rust-proof is claimed in a patent (U. S. 1,248,053) issued to William H. Allen of Detroit. Vapors containing phosphorus compounds are made use of. The process consists in subjecting articles of iron and steel, properly cleaned by pickling or sand blast, to the fumes or vapors of phosphorus pentoxide or anhydride, together with some aqueous vapor until surfaces of basic phosphates of iron are produced. These vapors may be produced in any desired manner, the preferred process consisting in subjecting a mixture of ground phosphate rock, coke and sand to a strong current in an electric furnace. The liberated phosphorus immediately changes to P_2O_5, and these fumes are drawn into the processing chamber by means of a suction fan. The fumes may be first passed through a dust chamber.

A saving of 25 per cent. in ammonia consumption by ice and refrigeration plants will mean several million pounds annually for munitions. A pound of ammonia will make 20 hand grenades.

The year 1917 holds the record for production of Portland cement, a total of approximately 93,554,000 barrels having been manufactured, an excess over the former high production of 1913 of nearly 1,500,000 barrels.

Lifting magnets are used successfully in recovering iron and steel objects that had been sunk in the water. Recently a Cutler-Hammer type of magnet was applied to lift 420 tons of pig-iron from a wrecked barge in the Tennessee river.



Pneumatic Patents March 26

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 26

1,260,416. TUNNEL CONSTRUCTION. Duncan D. McBean, New York, N. Y.

1. A means for preparing foundations for tunnel sections which comprises an air and water-tight open bottomed structure of slightly greater length than width and of the dimensions of a tunnel section, a horizontal and removable partition therein which forms a chamber beneath it for compressed air, and ballast tanks above it, and means for permitting access to the compressed air chamber, whereby a trench may be prepared under the structure when lowered to the bottom with its longer axis, transverse to the line of tunnel, of greater width than the tunnel to be laid therein.

1,260,428. PROCESS AND APPARATUS FOR CONTROLLING THE FLOW OF GLASS. William J. Miller, Swissvale borough, Pa.

1,260,445. METER FOR MEASURING GAS. Dorsey R. Potter, Clarksburg, W. V.

1,260,522. AIR-BRUSH. Thomas A. De Vilbiss and Godfrey Mueller, Toledo, Ohio.

1,260,524. INSTANTANEOUS-IGNITION MECHANISM FOR FUEL-OIL ATOMIZERS. Abner Doble, Detroit, Mich.

1,260,593. CONDENSING APPARATUS. Robert Suczek, Philadelphia, Pa.

1. The combination in a jet condenser, of a condensing chamber and a water collecting chamber, a diffuser forming a connection between said chambers and maintaining them independent when conducting cooling water, and means for extracting elastic fluid from said condensing chamber and delivering it at higher pressure into the elastic fluid above the liquid in said collecting chamber through a passage independent of said diffuser.

1,260,623. COMPRESSED-AIR OILER. Edwin E. Baker and Guy H. Snavely, Willows, Cal.

1,260,701-2. PNEUMATICALLY - OPERATED CHAIN SAW. Charles J. Olson, Muskegon, Mich.

1,260,833. WIND-OPERATED TOY. Harvey Thatcher, Maroa, Ill.

1,260,959. SUBMERSIBLE APPARATUS. Vittorio Boscavilla, San Francisco, Cal.

APRIL 2

1,261,011. PNEUMATIC SHOCK-ABSORBER. Samuel R. Cook, San Jose, Cal.

1,261,026. VACUUM-LIFT. Ernest N. Hogue, Wilkinsburg, Pa.

1,261,041. AIR-COMPRESSOR SYSTEM. Carl E. L. Lipman, Beloit, Wis.

1,261,044. AIR-VALVE. Mark McCracken, Portland, Oreg.

1,261,101. SPRAYING APPARATUS. Joseph T. Clark, De Graff, Minn.

1,261,185. PUMP FOR VACUUM-CLEANERS. Horace H. Taylor and Leonard A. Moberry, Oakland, Cal.

1,261,634. APPARATUS FOR DEVELOPING POWER. Leonard Slingland, Paterson, N. J.

1. An apparatus for developing power comprising a vertical column having air inlets at vertically spaced points, and power developing means in said column driven by an upwardly moving current of air therethrough.

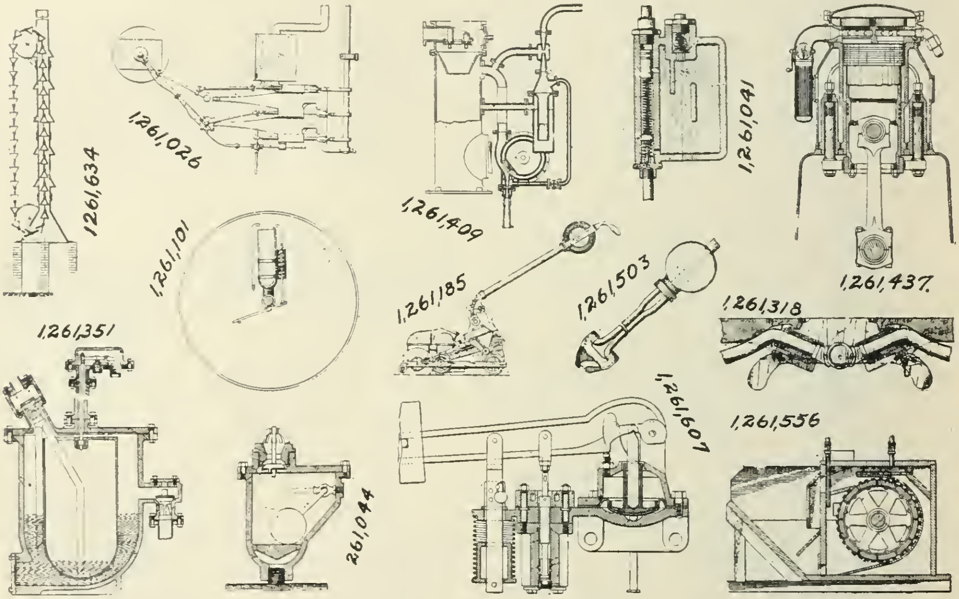
APRIL 9

1,261,753. FAN. Per August Anderson, New York, N. Y.

1,261,780. MILKING APPARATUS. Laurits Danesen, Minneapolis, Minn.

1,261,806-7. BLOWER. John E. Greenawalt, Denver, Colo.

1,261,940. APPARATUS FOR THE PRODUCTION OF PRESSURE GAS-VAPOR. Charles Edmund Johnson, Hobart, Tasmania, Australia.



PNEUMATIC PATENTS APRIL 2

1,261,318. AIR-LINE-HOSE-COUPLING DEVICE. Frank M. Thomas, Piggott, Ark.

1,261,351. APPARATUS FOR ELEVATING OR LIFTING ACIDS OR THE LIKE. Thomas Bradbear, Sparkbrook, Birmingham, England.

1. In an apparatus for elevating or lifting acids or the like, the combination of a tank sealed in an airtight manner; an open-topped float therein; means for admitting acid to the tank and exterior of the float and later to the interior of the float so as to sink the float; outlet pipes and valves to the tank and interior of the float; and means controlled by the float for admitting compressed air to the interior of the tank when the float sinks; for the purpose specified and substantially as set forth.

1,261,409. SURFACE AND JET CONDENSER. Maurice Leblanc, Val-sur-Seine, Croissy, France.

1,261,437. AIR-COMPRESSOR. William Reavell and Edwin Walter Jones, Ipswich, England.

1,261,503. ATOMIZER. Walter W. Figgis, Brooklyn, N. Y.

1,261,556. PROCESS FOR AERATING LIQUID. Frederick B. Kollberg, Bisbee, Ariz., and Max Kraut, Los Angeles, Cal.

1,261,607. REGULATOR FOR COMPRESSOR-UNLOADERS. Arthur E. Peters, Easton, Pa.

1,262,004. PNEUMATIC GUN. Walter F. Beachy, Chicago, Ill.

1,262,130. VALVELESS APPARATUS COMPRISING PISTONS HAVING AN ALTERNATING RECTILINEAR MOTION FOR DRAWING AND DELIVERING FLUIDS. Henri Steven, Montefurado, Spain.

1,262,239. PNEUMATIC VALVE. Joseph N. Newsom, St. Louis, Mo.

1,262,351. CUTTING AND WELDING TORCH. Allan H. Jones and Charles H. MacNichols, Oakland, Cal.

1,262,476. AIR-COMPRESSOR. Henry Fleming, Brooklyn, N. Y.

1,262,499. HAND BLAST-TORCH. Bert M. Howell, Newton, Ill.

1,262,510. PNEUMATIC PILLOW. Ida Kelly, Waco, Texas.

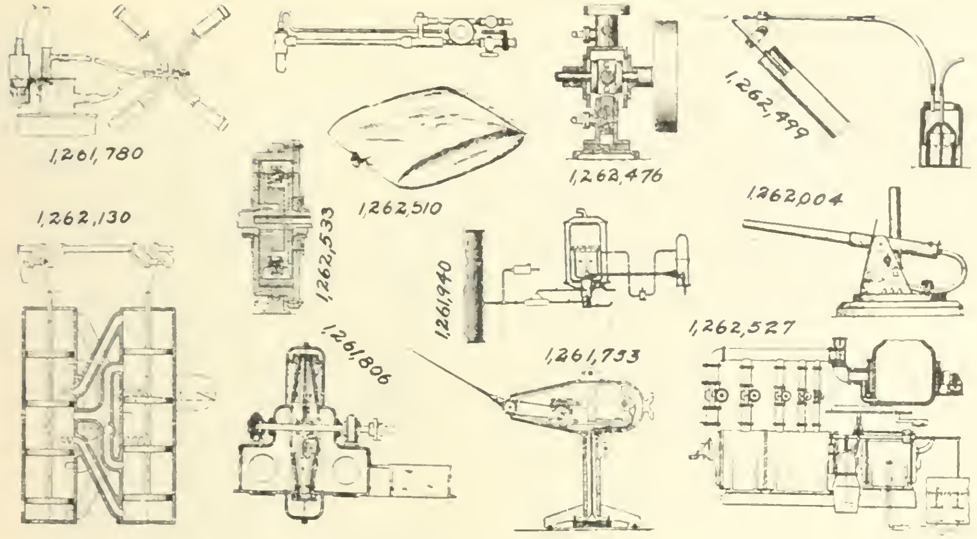
1,262,527. CENTRIFUGAL COMPRESSOR. Louis C. Loewenstein, Lynn, Mass.

1,262,533. ROTARY COMPRESSOR. George C. McFarlane, Denver, Colo.

APRIL 16

1,262,665. PUMP. Harry K. Hedges, Los Angeles, Cal.

1,262,667. AIR-COMPRESSOR CONTROL. Ebenezer Hill, Norwalk, Conn.



Pneumatic Patents April 9

1,262,670. PNEUMATIC TONE - PRODUCER. Robert Hope-Jones, deceased, North Tonawanda, N. Y., by Cecil Hope-Jones, temporary administratrix, North Tonawanda, N. Y.

1,262,881. PIANO-PLAYER. Eugene C. Wamelink, Cleveland, Ohio.

1,262,883. COMBINED AUTOMATIC AND STRAIGHT AIR VALVE MECHANISM. Frank H. Weimer, Nogales, Ariz.

1,262,900. COMBINED AUTOMATIC AND STRAIGHT AIR VALVE MECHANISM. John A. Adams, Nogales, Ariz.

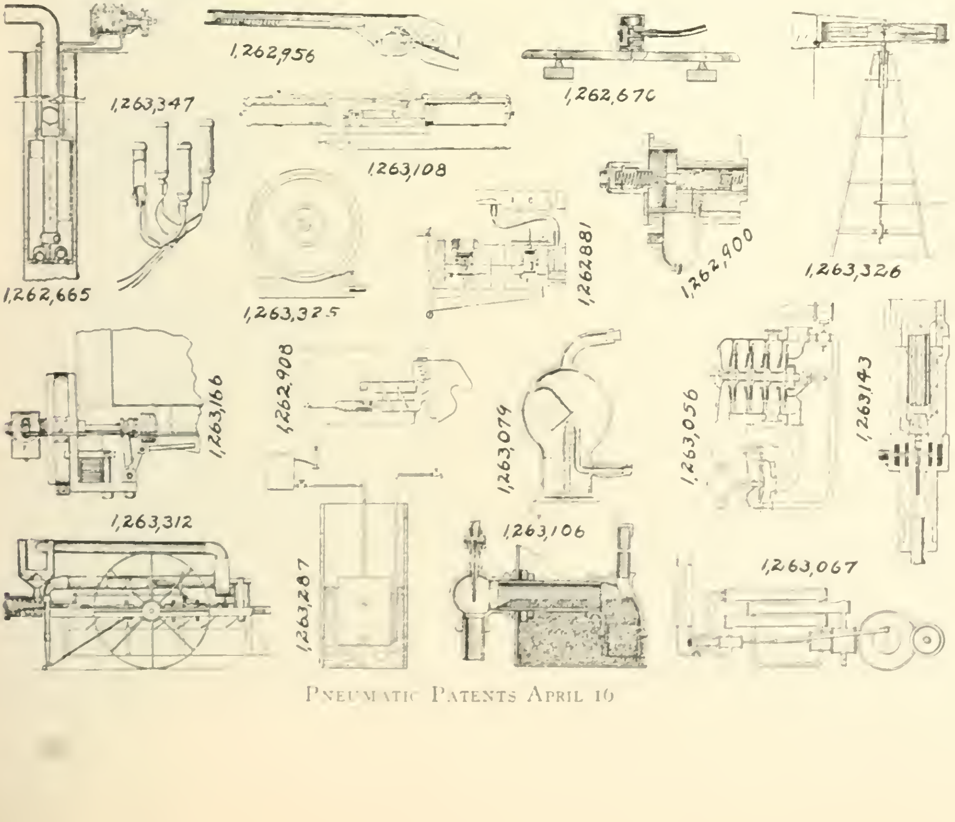
1,262,908. STEAM, ELECTRIC, AND COMPRESSED-AIR CAR-COUPLING. Carlos C. Ayres, Detroit, Mich.

1,262,956. POP-GUN. Arthur A. Karcher, Chicago, Ill.

1,263,056. OPERATION OF CENTRIFUGAL-COMPRESSOR PLANTS. Benjamin Graemiger, Zurich, Switzerland.

1,263,079. INHALING APPARATUS. Leon S. Leon, Chicago, Ill.

1,263,106. VACCUM - SANDER. Charles A. Pratte, Denver, Colo.



Pneumatic Patents April 16

1,263,108. FLUID-OPERATED MOTOR. Horatio C. Randall, San Francisco, Cal.

1,263,143. ROCK-DRILL. Thomas E. Sturtevant, Dover, N. J.

1,263,166. AIR-PUMP. Clinton L. Walker, Piedmont, Cal.

1,263,287. WATER - PRESSURE SYSTEM. James S. Ragains, Ottumwa, Iowa.

1. In a water pressure system, a tank adapted to be arranged in a body of water, said tank comprising a floating air chamber and a communicating water chamber, the latter having valves permitting the ingress of water and air and closing against the egress of the water, means for supplying air under pressure to the air compartment, and a draw-off pipe connected to the water compartment.

1,263,299. VACUUM-CLEANER. Emil F. Wemhoener, St. Louis, Mo.

1,263,312. BOLL - WEEVIL - DESTROYING MACHINE. Thomas H. Diserens, Dallas, and Frank C. McKay, Celina, Tex.

1,263,325. FLUID - DRIVEN MOTOR. Emil Klahn, Livingston, N. J.

1,263,326. WINDMILL. Anton L. Koester, Gorham, Kans.

1,263,347. TEAT-CUP CLAW FOR MILKING APPARATUS. John G. G. Eklundh, Columbus, Ohio.

1,263,354. PNEUMATIC - DIAPHRAGM FOLLOWER. Robert A. Gally, Cincinnati, Ohio.

APRIL 23

1,263,364. PNEUMATIC GRAIN-ELEVATOR. George Bernert, Milwaukee, Wis.

1,263,394. AIR-SEPARATOR. George S. Emerick, Philadelphia, Pa.

1,263,438. AUTOMATIC STOP MECHANISM FOR CARS. William E. Lawn and James A. Ryan, Rochester, N. Y.

1,263,468. SUCTION DREDGE-HEAD. John Reid, New York, N. Y.

1,263,519. AUTOMATIC TRAIN-PIPE COUPLING. Thomas R. Brown, Sparkill, N. Y.

1,263,556. PNEUMATIC ACTION FOR PLAYER-PIANOS. Mathew Hilgert, New York, N. Y.

1,263,592. TRAIN-STOPPING MEANS. William Brooks Murray, Danville, Ill.

1,263,722. LOCOMOTIVE SANDING DEVICE. William H. White, Roanoke, Va.

1,263,950. CONCENTRATION AND PURIFICATION OF SLUDGE ACID. William A. Slater, Fort Worth, Tex.

1,263,981. POWER SYSTEM AND PUMP. James Wilkinson, Schenectady, N. Y.

1,263,983. AIR-OPERATED MOTOR. Charles H. Winne, Troy, N. Y.

1,264,003. CARTRIDGE CONTAINING COMPRESSED OR LIQUEFIED GAS FOR INFLATING LIFE - PRESERVING BELTS, PNEUMATIC TIRES, AND OTHER PURPOSES. William Gould Brokaw, Paris, France.

1,264,043. AMMONIA-COMPRESSOR. George Ferguson, Apeldoorn, Netherlands.

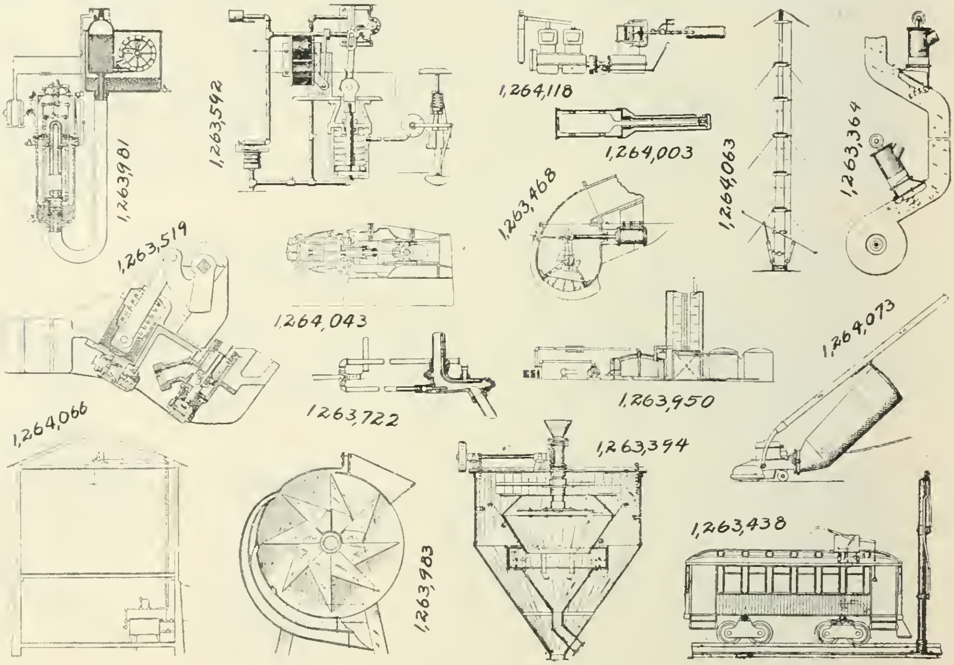
1,264,063. PNEUMATIC TELESCOPIC MAST AND ITS APPLICATIONS. Marcel Guichard, Paris, France.

1,264,066. HOUSE-VENTILATING AND FIRE-EXTINGUISHING SYSTEM. Andrew B. Hamil, Andrew O. Vensel, and Frank S. Bergstrom, Ray, Ariz.

1. A ventilating and fire extinguishing system including compressed air conducting means, water conducting means, means to cut off the compressed air conducting means, means to cut off the water conducting means, means including a fusible member to normally hold the air cut off means in open position and the water cut off means in closed position, and fluid pressure actuated means to close the said air cut off means and open the said water cut off means, when said fusible element is fused.

1,264,073. SUCTION-SWEEPER. Howard Earl Hoover, Chicago, Ill.

1,264,118. COMPRESSED-AIR AUTO-STARTER. Neal T. Nash, Hinton, Iowa.



Pneumatic Patents April 23

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC

Vol. xxiii JULY, 1918 No. 7

IT'S UP TO ME AND YOU

By Rufus T. Strohm

There's a powerful pile of talkin'
As to how we're goin' to win,
An' some of it's sound an' full of sense
An' much of it's weak an' thin;
For it mostly calls on others
For the help to pull us through,
When the simple truth of the thing is this—
It's a job for me an' you.

There's a lot of 'em loudly shoutin'
That an endless line of ships
Will knock the cup of the conqueror
From the Hohenzollern lips;
An' while I am not denyin'
That their wish is comin' true,
I'm sartin sure that the final punch
Will be up to me an' you.

Yet a bunch of 'em keep insistin'
That our hopes are based on guns,
An' others say that the nation's wealth
Will defeat the hated Huns.
While some pin faith to our fighters
In the work they're called to do;
But as for me, I am still convinced
It's a job for me an' you.

No, we ain't at the front in Flanders,
Where the blood-red rivers run,
But safe at home in the busy land
Where the war tasks must be done;
If earth's to be rid of the Kaiser
An' his dirty Prussian crew,
There's work for a hundred million hands—
So it's up to me and you.

—*American Machinist.*

DRY AIR AND COLD STEAM

By Frank Richards

The above title, which has been considered with care and is believed to be not inappropriate, may prove to be at first somewhat misleading, as the article does not deal with the precise conditions of which the normal reader will naturally first think.

The formula for computing the weight of a given volume of dry air at any temperature or pressure is extremely simple. The following gives the weight per cubic foot of dry air throughout the entire range of possible conditions:

$$W = 2.7093 \frac{P}{T}$$

in which W is the weight per cubic foot in pounds avoirdupois, P is the absolute pressure in pounds per square inch, and T is the absolute temperature, Fahrenheit, or the thermometer temperature plus 460 deg.

The above formula may, of course, be easily transformed as follows:

$$T = \frac{2.7093P}{W} \text{ and}$$

$$P = \frac{TW}{2.7093} \text{ or}$$

$$P = 0.3691 \ (TW)$$

0.3691 being the reciprocal of 2.7093.

Table I, compiled by the aid of the above formula, gives the weight of 1000 cu. ft. of dry air for a variety of combinations of temperature and pressure. Tables have been published with minuter intervals and a greater range but this is thought to be sufficient here.

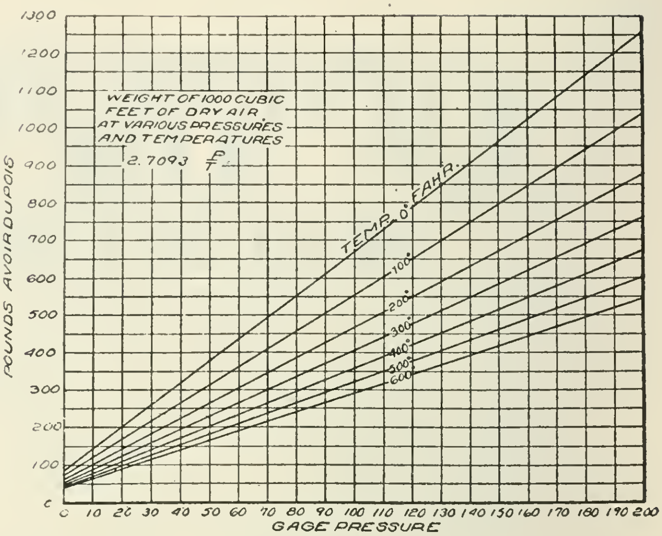


FIG. 1

The diagram, Fig. 1, embodies the same data as in the table, but not for the entire range of temperatures. As all the lines in Fig. 1 are straight lines, this diagram may be indefinitely extended by the aid of a straightedge and pencil.

These dry air data are generally the starting point in computations concerning performance and efficiency in compressed air practice, and there is more than a suggestion of unfairness or irrelevance in their employment. The ideal of efficiency, the 100 per cent. of efficiency, in air compression is generally based, first, upon the assumption that absolutely dry air is used, and second, that the operation of compression is isothermal, or with no rise of air temperature from the beginning to the end of the operation. Now, it happens that both of these assumed conditions are practically impossible, and the computed percentages of accomplishment are compared not with a possible but an impossible 100.

For common manipulation there is no such thing as dry air; and how could there be when we remember that one of the most important and persistent functions of the atmosphere is the conveyance and distribution of water over the earth?

This work of the air is the most familiar topic of our daily conversation. We think of the air as driving over the surface of our sphere and whenever it comes in contact with water picking up some of it, converting it into invisible vapor and flying along with it, until the conditions of pressure and temperature change sufficiently, and then dropping some portion of it, generally in the form of rain. In our familiar talks about the weather, when we believe a rainstorm impending we speak of the air as heavy, or laden with moisture. But the paradox of it is that the more the air is laden with moisture, the greater the proportion of water vapor it carries, the lighter it is, volume for volume; and when, as we say, the air is saturated with moisture it is lightest of all.

The simple fact is that the air does not pick up the water at all; but that the water, when it has the chance, forces itself in among the air molecules, diffusing itself equally all through the air and in the act displacing a portion of the air, so that any volume of moisture-laden air has not all the original volume of dry air in it, but the body becomes a mixture, the volume of air in it being re-

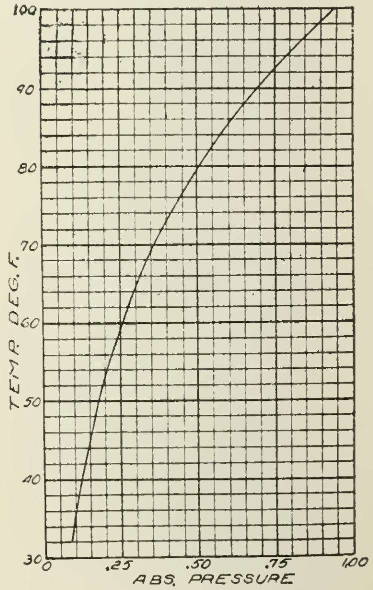


FIG. 2

TABLE I

Temp. Fahr.	Gage Pressure, Pounds																
	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	175	200
0	86.4	148.5	204.0	263.0	321.5	380.0	438.5	497.0	555.5	614.	672	731	790	849	908	968	1114	1260
10	84.6	142.5	199.5	256.8	314.5	372.0	429.2	486.3	543.3	600.6	658	716	774	832	880	947	1090	1233
20	82.8	139.5	195.5	251.6	307.1	364.5	420.5	477.0	533.9	589.0	645	701	757	813	869	922	1067	1208
30	81.1	136.6	191.6	246.5	301.5	357.0	412.1	467.2	522.1	577.1	632	687	742	797	852	908	1046	1184
40	79.5	133.8	187.6	241.5	295.4	350.3	403.8	457.6	511.4	565.2	619	673	727	781	835	890	1025	1161
50	78.0	131.0	183.9	236.7	290.5	343.2	396.0	448.7	501.4	554.1	607	660	713	766	819	873	1006	1139
60	76.4	128.3	180.3	232.3	284.0	336.2	388.2	440.2	492.	544.7	596	649	700	752	804	856	988	1116
70	75.0	126.0	177.0	228.0	279.1	330.2	380.8	431.6	482.4	533.2	584	635	686	737	788	839	967	1095
80	73.6	123.9	173.8	223.7	273.9	324.2	373.8	423.4	472.9	522.4	572	622	673	723	774	824	949	1074
90	72.3	121.8	170.7	219.5	268.8	318.2	367.0	415.4	463.9	512.2	561	611	660	709	759	809	932	1054
100	71.0	119.7	167.6	215.5	263.8	312.2	360.2	407.9	455.5	503.3	551	599	648	696	745	794	914	1035
110	69.8	117.6	164.5	211.5	259.3	307.0	354.2	401.1	448.1	495.0	542	589	637	685	732	780	899	1017
120	68.6	115.5	161.8	208.0	254.9	301.8	348.1	396.4	440.3	486.6	533	579	626	673	720	767	884	1001
130	67.4	113.5	159.0	204.5	250.5	296.6	341.6	392.4	429.6	477.0	524	570	616	662	708	754	869	984
140	66.8	111.5	156.5	201.5	246.5	291.5	336.4	381.3	426.2	471.1	516	561	606	651	696	742	855	968
150	65.2	109.6	154.1	198.5	242.5	286.5	330.8	375.1	419.3	463.6	508	552	596	640	685	730	841	953
200	60.3	101.4	142.7	184.0	224.8	265.5	305.4	347.3	388.2	429.1	470	511	552	592	633	674	776	879

duced, or a portion of it crowded out, and the reduction of air volume being made up by an equivalent added volume of water vapor.

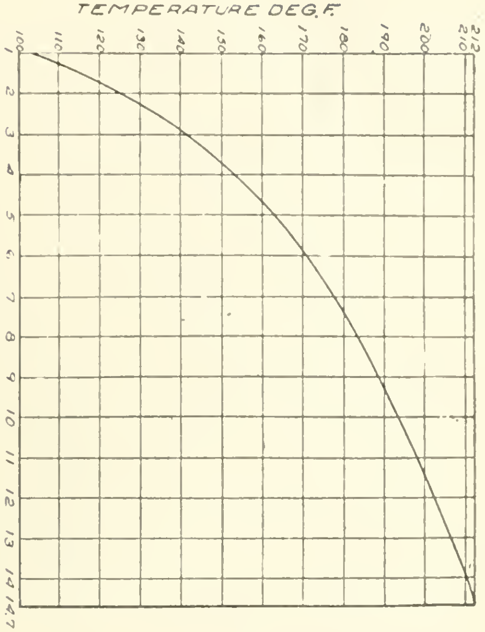


FIG. 3

Here we come in sight of the cold steam of which the title of this article speaks. The water vapor mixed with the air is true steam, produced by boiling or evaporation; and our view of the actual conditions becomes immediately clearer if we agree to consider and to speak of any body of free air, dry air only in name, as a mixture of air and steam.

We speak familiarly of the boiling point of water as something fixed, but water is really as ready to boil at one temperature as at another if it can adjust itself to the pressure conditions. Here is a little list, picked from the steam table in Kent's pocket book, of the ordinary atmospheric temperatures and the absolute pressures at which water boils at these several temperatures.

Temp. Deg. F.	Abs. Pressure	Temp. Deg. F.	Abs. Pressure
32	.089	70	.359
40	.122	80	.502
50	.176	90	.692
60	.254	100	.943

These data are given graphically in Fig. 2. The following is a continuation of the preceding list with the absolute pressures in even pounds.

Abs. Pressure	Temp. Deg. F.	Abs. Pressure	Temp. Deg. F.
1	102	9	188
2	126	10	193
3	141	11	198
4	153	12	202
5	162	13	206
6	170	14	210
7	177	14.7	212
8	183		

Figure 3 embodies the same data.

TABLE II

Temp. Fahr.	Abs. Steam Pres.	Abs. Air Pres.	Temp. Fahr.	Abs. Steam Pres.	Abs. Air Pres.
0	.0215	14.664	112	1.340	13.345
12	.0370	14.648	122	1.777	12.908
22	.0572	14.628	132	2.331	12.354
32	.0889	14.596	142	3.027	11.658
42	.1312	14.554	152	3.891	10.794
52	.1906	14.494	162	4.955	9.729
62	.2728	14.412	172	6.257	8.428
72	.3851	14.299	182	7.836	6.849
82	.5359	14.149	192	9.728	4.955
92	.7367	13.948	202	11.996	2.689
102	.9992	13.686	212	14.685	0.000

TABLE III

Temp. Fahr.	Dry Air	Saturated Mixture	Air in Mixture	Water Vapor in Mixture
0	86.3	86.3	86.2	.077
10	84.4	84.3	84.2	.119
20	82.7	82.6	82.4	.185
30	80.9	80.8	80.5	.279
32	80.7	80.5	80.2	.300
40	79.2	79.1	78.7	.408
50	77.7	77.5	76.9	.584
60	76.3	75.9	75.0	.823
70	74.9	74.2	73.0	1.146
80	73.5	72.5	70.9	1.572
90	72.2	70.8	68.8	2.130
100	70.9	69.1	66.3	2.848
110	69.7	67.3	63.5	3.770
120	68.5	65.5	60.5	4.953
130	67.3	63.5	57.1	6.384
140	66.1	61.3	53.1	8.188
150	65.0	59.0	46.5	10.396
160	64.0	56.4	43.2	13.080
170	63.0	53.6	36.9	16.317
180	62.0	50.4	30.2	21.198
190	61.0	46.9	22.1	24.797
200	60.2	43.1	12.9	30.233
210	59.2	38.8	2.	36.8
212	59.1	37.9	000.00	37.9

In the mixture of dry air and cold, or low temperature, steam which we are considering, the steam retains its own characteristics. It for instance, exercises its elastic force as usual, or produces the resultant pressure due to the temperature. The total pressure of the mixture, therefore, consists of the sum of this pressure added to the air pressure, and does not consist of the air pressure alone.

Table II gives the pressures of both the air and the cold steam, as we are calling it, at various temperatures all the way from 0 to 212 deg. F., the boiling point of water at sea-level atmospheric pressure. The diagram Fig. 4 shows this in an interesting way and should he worth studying. Beginning at zero Fahrenheit, the steam pressure or expansive force is very small, but continually increases with the rise in temperature, the air pressure decreasing correspondingly. At any point, measuring vertically, the sum of the steam pressure added to the air pressure—

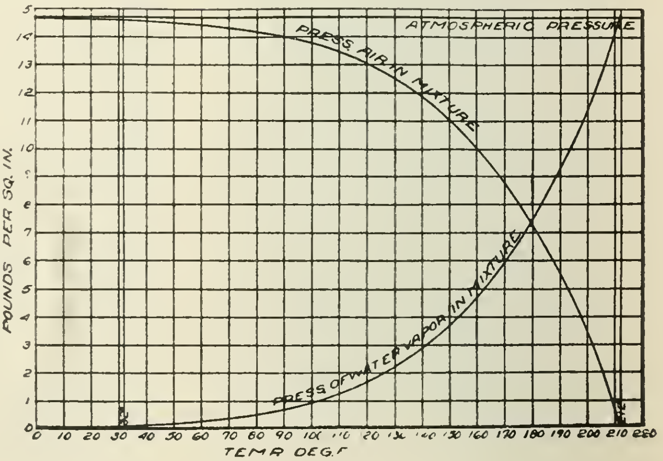


FIG. 4

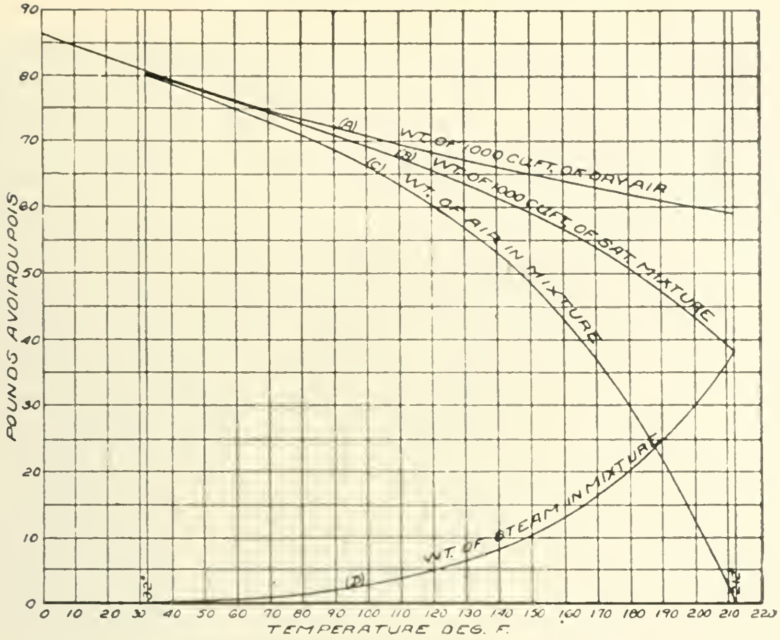


FIG. 5

barring slight inaccuracies in the drawing of the curves—equals the atmospheric pressure.

It is to be remarked all along that the actual constituents of the mixtures tabulated are not the same all through, but are constantly different for the different temperatures. The quantities or weights of both air and steam in saturated mixtures are given in Table III, and are shown graphically in Fig. 5. Referring to the latter, curve A shows the weight of dry air at sea level and at different temperatures; B, the weights of saturated mixtures of air and cold steam; C, the weight of air in the mixture, and D the weight of steam in the mixture, the sum of C and D being always equal to B and always less than A. It is thought that this diagram can sufficiently speak for itself without further explanation.

The word "saturated" in the foregoing connection, suggesting a sponge saturated and heavy with water, is far from satisfactory and as misleading as possible, but nobody suggests anything better.—*Power Plant Engineering.*

And now Birmingham, "the workshop of the world," has begun to turn out ships among its many products; not, indeed, in the completed stage, but in parts which are sent to seacoast localities to be assembled.

HOW THE AIRPLANE PROPELLER DOES ITS WORK

A highly interesting paper upon the above topic has been prepared by Professor Morgan Brooks, of the University of Illinois, for presentation at the June meeting, Worcester, Mass., of the American Society of Mechanical Engineers. The following abstract is from the Journal of the Society.

The term air screw, considered by many writers on aeronautics as descriptive of propeller action, is a misnomer. The theory of the marine propeller, which seems to be adequately presented by the screw principle, has been transferred to air propulsion without sufficient regard for the extreme difference in the two fluids as to elasticity.

In view of the current theory that air is driven by a propeller with a velocity which should not exceed the product of the pitch of the propeller by its revolutions, it was a surprise to find that air may be driven backward at a velocity nearly twice as great as this product indicates. The fact was so revolutionary that it caused the greatest care in measurement before its acceptance. Recognition of this superspeed action of propellers explains many anomalies of air propulsion and will undoubtedly lead to more exact formulae for thrust and power calculations.

The purpose of this paper is to give proofs of the above possibility and to point out some of the applications of superspeed theory as it relates to propellers and blowers.

Superspeed is not readily observant with the standard type of two-blade propeller owing to the masking of this effect by the mingling of high-speed air with a much larger quantity of inert air lying between the propeller blades. Therefore the measurements were made upon a special type of propeller having extremely short blades of great width, sweeping the entire circumference of the disk area.

A propeller of the wide-blade type described having an experimental mean pitch of 2.53 ft. gives a wind on static test that flows 3.33 ft. per revolution, regardless of the speed of the propeller. These values were determined for the writer by Prof. E. P. Lesley at the Leland Stanford, Jr., University wind tunnel, confirming the writer's own measurements. The superspeed ratio, 3.33/2.53, is 1.32, and these figures bear so direct a trigonometrical relation to the blade angle as to suggest that air instead of being swept backward by a screw pressure is driven back by precise reflection or batting action.

The reflection theory is supported by data obtained with a blade of 28 deg. angle and by other confirmatory tests. In this connection an investigation was also made of the more complex condition of a propeller operating in a wind tunnel with wind conditions corresponding to those on a flying plane.

Among other things it was found that for low blade angles, where the superspeed ratio is more pronounced, the air leaves the propeller at higher velocity near the blade tips than part way in, a condition inconsistent with the screw theory for standard-type constant-pitch propellers.

Eiffel in his "Recherches" presents an elaborate collection of data showing that this condition exists, but the reflection theory for the first time explains it.

Light ribbons placed in the air flow from a static propeller show that the air moves in a direction strictly perpendicular to the blade angle, a condition determined by the reflection theory but not by screw action. Moreover, these ribbons indicate that the stream contracts slightly in diameter as it leaves the propeller, whereas with the squeezing action of a screw the air would be expected rather to expand.

The most convincing demonstration of the fact that the air leaves a propeller at a greater velocity than the propeller screw advance is found in a test made with two propellers connected in tandem. Calling the forward propeller a blower for the sake of distinction, assume that it provides a wind at 30 miles per hour, or 44 ft. per sec., and that the propeller is driven by this wind at a speed just above idling speed, such that its revolutions times pitch is, say 48 ft. per sec. An anemometer shows a velocity of about 50 ft. per sec., but if the blower be shut down while the speed of the propeller is maintained constant, the wind velocity rises to 75 ft. per sec. instead of remaining constant as demanded by the screw theory.

The acceptance of superspeed action gives a basis for the evolution of dynamic thrust equations without the questionable assumption of blade activity over a larger portion of the propeller disk than that covered by the blades alone. The proper interpretation of superspeed may reconcile thrust and power values as derived from static tests with those of wind tunnels or of flight. Today it seems to be the common opinion that flying performance may not be predicted from static tests. With the precise air-dynamics formulæ sure to be developed, a single static test of a propeller should furnish all necessary data for the production of complete flying-performance curves.

The writer shows analytically that apparently the wind-tunnel blower relieves the propeller of a portion of the static thrust at a given propeller speed represented by idling speed, even though the propeller giving superspeed sends air backward when tested statically at the speed V/p, where V is plane velocity and p the propeller pitch. The writer shows that under his formula the flying thrust at 30 per cent slip is found to be 51 per cent of the static thrust at the given propeller speed.

What is said to be the world's knitting record is claimed by Mrs. Fred Springer, of Detroit, who won a contest conducted by the Red Cross in which there were more than 700 contestants. In two hours Mrs. Springer completed twenty-one inches of a man's sock, the leg, heel and three-fourths of the foot. This of course is not comparable with the shipbuilding riveting record.

ADVECTION FOG, SEEN FROM MOUNT WILSON, CALIFORNIA

FOGS*

In general a fog differs from a cloud only in its location. Both are owing to the cooling of the atmosphere to a temperature below its dew-point, but in the case of the cloud this cooling usually results from vertical convection, and hence the cloud is nearly always separated from the earth, except on mountain tops. Fog, on the other hand, is induced by relatively low temperatures at and near the surface, and commonly itself extends quite to the surface, at least during the stage of its development. In short, fog consists of water droplets or ice spicules condensed from and floating in the air near the surface; cloud, of water droplets or ice spicules condensed from and floating in the air well above the surface. Fog is a cloud on the earth; cloud a fog in the sky.

According to the conditions under which they are formed, fogs may be divided into two general classes—radiation fogs and advection fogs.

RADIATION FOG

Fog is likely to form along rivers and creeks and even in cleared mountain valleys during any still, cloudless night of summer and, especially, autumn. In the course of a calm warm day much water is evaporated into the lower atmosphere of such regions, where in large part it remains as long as there are no winds. Hence this air, because it is humid, and the adjacent surface of the earth lose much heat during the night by radiation to the clear sky. In many cases they cool in the end to a temperature below the dew-point, and thus induce a greater or less volume condensation on the always-present dust motes that results in a correspondingly dense fog. Such fog, however, is not likely to occur during cloudy nights, because the air seldom then cools sufficiently, nor during high winds, since they dissipate the humidity and also through turbulence prevent the formation of excessively cold aerial lakes.

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*From "Physics of the Air" by W. J. Humphreys, Professor of Meteorological Physics, United States Weather Bureau, in Journal of Franklin Institute.

The distinctive factor in the formation of this type of fog is the free radiation of the ground and the lower air by which the latter is sufficiently cooled to induce condensation. Hence fogs formed in this manner are properly termed "radiation fogs," sometimes also called "land fogs" and "summer fogs."

ADVECTION FOG

Whenever warm, humid air drifts over a cold surface its temperature is reduced throughout the lower turbulent layers by conduction to that surface and by mixture with remaining portions of the previous cold air and a correspondingly dense fog produced. Hence fog often occurs, during winter, in the front portion of a weak cyclone; also whenever air drifts from warm water to cold—from the Gulf Stream, for instance, to the Labrador Current; and wherever gentle ocean winds blow over snow-covered land—circumstances that justify the terms "winter fog" and "sea fog" (drifting on shore in places, and even some distance inland. Similarly, a cold wind drifting or spreading under and through a body of warm, humid air also produces a fog, though usually a comparatively light one. This explains the fog that frequently forms, during winter, along the front of a "high," and the thin fog that occasionally is seen over lakes on frosty autumn mornings, when the water appears to be steaming—actually evaporating into air already saturated and thus inducing condensation. It also explains the frequent occurrence of "frost smoke" on polar seas.

If the wind is strong the turbulence extends through a comparatively deep layer. Hence in the case of warm air drifting over a cold surface if the movement is rapid the total duration of contact between any portion of the air and that surface is likely to be so brief that but little cooling can take place and no fog be formed. Similarly, it ususually also happens that fog does not form when the cold wind blowing over a warm, humid region is even moderately strong. Here the turbulence mixes the excessive humidity near the surface through so large a volume that saturation commonly is not produced, nor, therefore, any trace of fog.

From the above it appears that all fogs that result from the drifting of warm, humid air over cold surfaces, as also those that are produced by the flow of cold air over warm, humid regions, are but effects of temperature changes induced by the horizontal transportation of air; hence the proposed general name, "advection fog." The term advection is preferred to convection because the latter is practically restricted, in meteorological usage, to a change of level, whereas in the case under consideration only horizontal movements are concerned. The contradistinction, therefore, between "advection fog" and "convection cloud" is obvious, and, presumably, worth while.

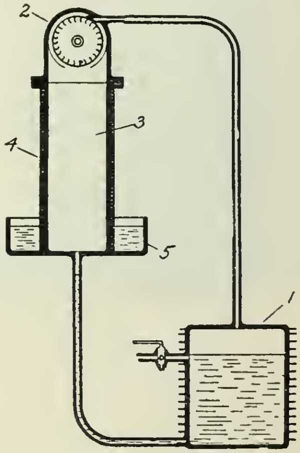

FIG. I

POWER FROM THE HEAT OF THE ATMOSPHERE

By Perry Okey*

As expressed by Clausius—"Heat cannot of itself pass from a colder to a hotter body," and by Lord Kelvin—"It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects." The second law of thermo-dynamics has been generally understood to mean that work may not be obtained from the inherent heat of the atmosphere.

Although these statements apparently have been mathematically demonstrated, the mind nevertheless rebels against a law which denies the possibility of using any portion of the thousands of millions of horsepower existing at all times in the atmosphere. Such mental rebellion led the writer to attempt the utilization of this energy in spite of what is declared to be the second law of thermodynamics.

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*Journal American Society of Mechanical Engineers.

The result of this effort, which thus far has been imaginative rather than through mathematical treatment, seems to indicate several methods by which work may be realized from the heat in the air.

A simple apparatus which demonstrates the fact has been constructed and operated by the writer and will be understand by referring to Fig. 1. This apparatus consists of but three essential elements, viz., the boiler 1, the turbine 2, and the condenser 3. A pipe connects the top of the boiler to the nozzle of the turbine and the casing of the turbine opens directly into the condenser. The condenser is provided with means for evaporating water from its outer surface. In the sketch this is shown as a fibrous covering 4, which keeps moist by drawing water from the receptacle 5 by its capillarity. A pipe connects the bottom of the condenser to the bottom of the boiler.

The operation will be most easily understood by assuming the plant completed and ready for starting. The first act is to exhaust the air from the entire system through the valve in the boiler. A quantity of liquefied gas sufficient to partly fill the boiler is next introduced through the same valve, which is then closed. Finally the receptacle at the bottom of the condenser is filled with water.

The heat interchanges or cycles, of which there are two, commence as soon as evaporation of water takes place from the exterior of the condenser. The water, in the act of evaporating, removes an increment of heat from the condenser, causing a reduction in temperature and consequently a condensation of the vapor therein. This, in turn, brings about a difference in pressure between the condenser and the boiler which is available for operating the turbine. The condensate from the condenser enters the boiler at a temperature lower than that of the atmosphere, which enables the boiler to absorb an amount of heat from the atmosphere equivalent to the amount rejected by the condenser to the atmosphere less the amount converted into work. The difference of level between the liquid below the condenser and that in the boiler serves in place of a pump for feeding the boiler.

The little plant shown in Fig. 1 has been running continuously for some time, using sulphur dioxide as the working fluid. It will be seen that the capacity of the plant is a function of the relative humidity of the atmosphere, being greater in a dry climate than in one of more humid character. Operation would cease when the relative humdiity reached 100 per cent, or when the temperature fell to 32 deg. fahr.

That the mechanism operates at all is due to the fact that nature, in the course of her unending processes, is continuously depositing moisture out of the air, rendering it again capable of absorption in the manner and with the result described. If we were compelled to remove the moisture content, no doubt the work cost would balance the work derived, but if nature does this work without cost to us, it would seem that, as far as our interests are concerned, mechanical work may actually be derived from the heat in the air. Furthermore, it appears that under these conditions and through the agency of evaporating water, heat does in fact pass from a cold body to a hotter medium, for the heat from the cold condenser is rejected to a hotter atmosphere.

If these conclusions are correct—and they must be, since the machine runs—then the statements of Clausius and Kelvin are not strictly true.

The efficiency of the cycle, based on the standard of Carnot, is low, but it may even be that the Carnot cycle itself is not the final word in heat efficiency.

The question as to commercial possibilities has been asked, and after a careful study of the matter the writer is convinced that no commercially successful results may be hoped for, although remarkable performances might be realized if no attention were paid to investment costs.

The noncompressibility of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.—*Marine Engineering.*

TABLE I—APPLICATIONS TO WHICH SYNCHRONOUS MOTORS ARE ADAPTED

TYPES OF PLANTS USING SYNCHRONOUS MOTORS AND THE MACHINES WHICH ARE DRIVEN	AIR COMPRESSORS	AMMONIA COMPRESSORS	CENTRIFUGAL PUMPS	CONVEYORS	CRUSHERS	FANS	FREQUENCY CHANGERS	GRINDERS	JORDANS	LINE SHAFTS	MIXERS	MOTOR GENERATOR SETS	PULP GRINDERS	RECIPROCATING PUMPS	ROLLS	SCREW PUMPS
AUTOMOBILE PLANTS	●						●			●		●				
BRICK AND CLAY PLANTS			●	●		●										
DRAINAGE PLANTS			●				●									●
ELECTRIC LIGHT AND POWER PLANTS							●					●		●		
FLOUR MILLS										●						
FOUNDRIES	●											●				
ICE AND REFRIGERATING PLANTS		●										●				
IRON WORKS	●						●					●				
IRRIGATION PROJECTS			●													
MINES.	●		●			●						●				
MARBLE AND STONE CUTTING PLANTS								●		●						
METAL WORKING PLANTS	●									●					●	
OIL REFINING PLANTS			●									●				
PAPER MILLS									●			●	●			
QUARRIES	●				●											
RUBBER MILLS										●		●			●	
RAILROAD SHOPS	●									●						
SHIPYARDS	●											●				
STEEL PLANTS	●											●				
SUCTION DREDGES			●													
SEWAGE DISPOSAL PLANTS			●									●				●
STONE CRUSHING PLANTS				●						●						
TEXTILE MILLS										●		●				
WATER WORKS			●											●		
MISCELLANEOUS	●	●	●			●	●			●		●		●		

ADAPTABILITIES OF SYNCHRONOUS MOTORS

By Will Brown*

Synchronous motors cannot be used profitably on small loads. This generally means anything under 100 hp. An exception should be made in the case of small synchronous motor-generator sets, however. They cannot be used on intermittent loads involving frequent starting and stopping, such as crane motors, reversible hoist motors, etc. They cannot be used where variable speed or adjustable speed is demanded unless some mechanical means of regulating the speed change is provided. They cannot be used where it is necessary to start up the full load from rest unless a clutch or some other mechanical method of easing the starting condition is supplied.

Where synchronous motors may be, and are actually, employed is attested by Table 1. It does not by any means cover the full field of possible applications, but it does indicate the already wide range of these motors and the promise of a much greater use in the future.

Where a heavy and fairly continuous load can be driven at a constant speed, there is generally an opportunity to install a synchronous motor. High efficiency and reliability of service are the two great essentials in such work. It is safe to say that a synchronous motor is always higher in efficiency than an induction motor of corresponding rating. At low speeds the advantage in favor of the synchronous motor is even greater than at high speeds.

There are many heavy-duty machines which must be run at low speeds. Formerly, if these machines were to be driven by motors it was necessary to install some form of belt or gear drive. They can now be directly connected to synchronous motors and operate efficiently at speeds as low as 72 r.p.m.

STARTING ABILITY

The old handicap of synchronous motors was their inability to start up from rest while carrying a mechanical load. This handicap has been overcome to a greater extent than most engineers realize. There are practical examples of large synchronous motors developing a starting torque as high as 50 per cent. of full-load torque obtained without a prohibitively large kva. input. The future will probably bring even more remarkable results.

It is a fundamental fact that a low-speed synchronous motor cannot develop as high an initial starting torque with the same starting voltage as the high-speed motor, it being understood that horsepower ratings of the two motors are the same. For example, a certain motor with a synchronous speed of 200 r.p.m. can develop a starting torque of 35 per cent. of full-load torque on the 40 per cent. voltage tap with an input of 130 per cent. of the full-load kva., whereas a 600-r.p.m. motor can develop a starting torque of 40 per cent. of full-load torque on the 40 per cent. voltage tap with an input of 115 per cent. of full-load kva.

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*Condensed from Electrical World.

VARIABLE LOADS

Many types of heavy-duty machines requiring variable output are now designed so that they can be started and driven by synchronous motors. For instance, in a certain reciprocating pump installation a variable stroke is automatically obtained by means of bell cranks and by shifting the cylinder. This permits varying the delivery from zero up to 4200 gal. per minute.

Mechanical methods for changing the inlet or outlet passages for fans and blowers permit the use of constant-speed motors where formerly only adjustable speed motors could be used. There are already a number of such installations—for instance, large exhaust fans such as are used on mine shafts, etc.—and it seems quite likely there will be many more in the future.

EFFICIENCY AND RUGGEDNESS

The high efficiency which can be secured with a synchronous motor is well illustrated in the following installations: One marble-working concern has been operating a 150-hp. synchronous motor driving a line shaft for nearly four years. The choice originally lay between an induction motor and a synchronous motor. The higher efficiency obtained by the synchronous motor brought a saving in the first two years of operation which more than made up for the higher original cost of the synchronous motor.

There is a rather interesting installation in a paper mill where a 1150-hp. synchronous motor is driving two direct-coupled pulp grinders. No difficulty has been experienced either in starting or running. An induction motor of similar horsepower driving a similar load has caused more or less trouble, which is generally traced to the very small air gap. The slightest wear in the bearings alters the air gap sufficiently so that very heavy magnetic pull is set up on one side of the rotor and quickly wears the bearings down still more until the time arrives when the motor must be stopped and the bearing repaired. Very frequently the windings of the armature are damaged also. The synchronous motor, owing to its comparatively large air gap, is much more rugged and dependable for operation on low speed, direct connected loads.

DRIVING AIR COMPRESSORS

Air compressors, especially those of sufficiently large capacity to require 100 brake horse-power or more, can be economically and efficiently driven by synchronous motor. The old idea that it was necessary to change the piston speed with change in air demand has been abandoned. Mechanical methods of regulation on the compressors now permit the driving motor to operate at a uniform speed.

In practice synchronous motors are used bolt belted and direct connected to the compressor. On direct connected units the speeds required are generally within the range of 260 r.p.m. down to 120 r.p.m. Probably the greatest number of direct connected synchronous-motor-driven compressors operate at a speed in the neighborhood of 200 r.p.m. This speed is very much higher than was ever thought advisable by compressor builders a few years ago. The increased speed has been made possible by the adoption of a light plate valve with a low lift. The time required to open and close such a valve is so small that it permits operating the piston at much higher speeds.

TABLE II — EFFICIENCY AND POWER-FACTOR TESTS OF 560-HP., 225-R.P.M SYNCHRONOUS MOTOR DIRECT-CONNECTED TO AIR COMPRESSOR

Exciting current remaining constant at all loads

	Quarter Load	Half Load	Three-Quarters Load	Full Load	One-and-a-Quarter, Load
Efficiency	92.6 per cent	95.6 per cent	96 per cent	96 per cent	95.4 per cent
Power factor	73 per cent Leading	93 per cent Leading	98 per cent Leading	100 per cent	98 per cent Lagging

In starting an air compressor the pressure can be relieved by a by-pass, so that the motor has only the friction load and inertia to overcome in breaking the compressor from rest. This is very easily taken care of without drawing excessive kva. from the line, and the motor can pull into synchronism without causing objectionable fluctuation of the line voltage.

Since the load factor of a compressor is generally high, and since the power factor of a synchronous motor can be maintained at unity, a favorable rate can usually be secured when energy is purchased from a central station. The fact that these motors operate at unity power factor or slightly leading (at part loads) should appeal with even greater force to plants generating their own energy. the power factor and efficiency obtained with a typical direct connected synchronous-motor-driven air compressor are shown in Table II.

Recently there has been an enormous demand for large synchronous-motor-driven air compressors among the shipyards of the country. They range in size from 150 hp. to 1200 hp. Among other lines of industries using these machines might be mentioned mines, foundries, automobile factories, structural steel works; in fact, any industry where a large quantity of compressed air is used. In driving tunnels the air pressure can be maintained in the headings by means of a battery of low pressure compressors driven by synchronous motors.

AMMONIA COMPRESSOR DRIVE

The large ammonia compressors used in ice plants (50 ton or over) are driven, in exactly the same way as air compressors, by either belted or direct connected synchronous motors. The starting duty required is, however, somewhat more severe than in the case of ordinary air compressors. In order to obtain the required starting torque it is sometimes necessary to use a higher voltage tap on the starting compressor than would be necessary with the corresponding air compressor installation. The large flywheel combined with the inertia and friction of other moving parts requires that the motor be specially designed to produce maximum starting torque.

The preference for direct-connected synchronous-motor-driven ammonia compressors is very markedly shown in the ice and refrigerating plants recently constructed or now in course of construction. It may be said safely that the energy cost with direct-connected synchronous-motor-driven machines is less per ton of ice manufactured than is the case with any other type of motor drive.

Once it was considered essential, in order to meet the varying demands for ice, that the speed of the ammonia compressors should be adjustable. This is no longer necessary. In place of one large unit running at variable speeds, ice plants can have two or more smaller units which run at constant speed. By running different combinations of the compressors in parallel, fluctuation in demand can be easily cared for without provision for speed adjustment. When the demand drops to a minimum the smallest compressor only may be used, so the losses may be kept at the minimum. It can be seen that the over-all efficiency of such a plant will be very much higher than in the old-fashioned variable-speed plant.

Another method of varying the output of the compressor at constant speed is by means of an adjustable clearance pocket, or cylinder, at each end of the compression cylinder. By

TABLE III—EFFICIENCY AND POWER-FACTOR TESTS OF 450-HP., 200-R.P.M. SYNCHRONOUS MOTOR DIRECT-CONNECTED TO AMMONIA COMPRESSOR

Exciting current remaining constant at all loads

	Quarter Load	Half Load	Three-Quarters Load	Full Load	One-and-a-Quarter Load
Efficiency....	87.7 per cent	92.6 per cent	93.7 per cent	94 per cent	93.8 per cent
Power factor......	70 per cent Leading	94 per cent Leading	99 per cent Leading	100 per cent	99 per cent Lagging

means of these the clearance can be increased and the capacity lowered to any desired point between full load and one-quarter load or even lower. Thus the flexibility of the compressor is fully equal to that of the old adjustable-speed compressors driven by low-speed Corliss engines.

The efficiency curve of the synchronous motors is quite flat throughout a wide range of load, so that there is very little loss in efficiency on the part of the motor when run at part loads. As far as the compressor is concerned, the efficiency at part loads seems to be practically as good as at full load. This is due to the general conditions under which ice-manufacturing plants operate. The efficiency, power factor and starting torque for a typical synchronous-motor direct connected to an ammonia compressor are indicated in Table III.

MEASURING AIR DELIVERY OF ROTARY BLOWERS

For the purpose of investigating various theories, Professor W. Trinks of the Carnegie Institute of Technology has made an interesting series of tests of a rotary blower built by the P. H. & F. M. Roots Company, Connersville, Ind.

Tests to determine the volume of gas delivered by centrifugal exhausters are more easily and more frequently made than the corresponding tests of rotary exhausters, because the discharge of the latter is pulsating. Nozzles or orifices cannot be used to measure pulsating flow unless the pulsations are eliminated. These tests are seldom performed on rotary exhausters chiefly because every rotary exhauster is a meter of the displacement type, so that the speed of the exhauster is a measure of the quantity of gas delivered. A definite quantity of gas is imprisoned during each cycle and delivered positively, except for the leakage or slip. The latter is constant regardless of speed, depending only upon the inlet and outlet pressures, and upon the density of the gas being exhausted.

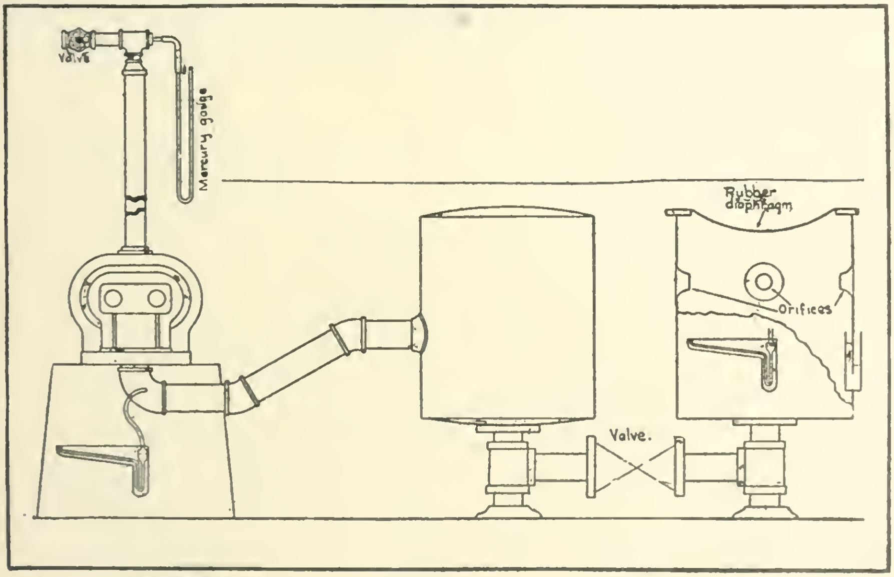


FIG. 1

In each rotary exhauster there is a speed, commonly referred to as the slip, at which the leakage accounts for all of the gas handled by the exhauster. Above this speed the exhauster delivers its full displacement to the discharge system. The probable delivery, therefore, is found by multiplying the difference between the slip speed and the actual speed by the displacement of the exhauster per revolution. Evidently, the volumetric efficiency increases with the speed. When the speed of the exhauster is 10 times the slip speed, the volumetric efficiency is 90 per cent. Some operators of rotary blowers and exhausters believe that other factors enter into the rate of delivery. The belief is rather general that pressure drop due to friction in the intake pipe reduces the delivery and counteracts the increase in efficiency due to the higher ratio of actual speed to slip speed.

The arrangement of the testing apparatus employed by Prof. Trinks is shown in Fig. 1. The air from the blower enters the right hand tank through standard nozzles. This tank is closed at the top by a thin rubber diaphragm the mass of which is so small that it vibrates with the pulsations of the air in the intake pipe and maintains practically a steady flow of air through the nozzles. When the blower is in operation the oil in the draft gage near the blower vibrates with the pulsations in the air column, while the oil in the draft gage at the measuring tank is motionless. The water seal at the extreme right in Fig. 1 saves the rather expensive rubber diaphragm in case the blower is started with all the nozzles closed. The intermediate tank between the measuring tank and the blower is not absolutely necessary in this test, because the vacuum produced is not greater than the rubber diaphragm will allow.

The relation between the quantity of air delivered and the speed of the blower is shown in Fig 2. The test of the blower produced the left-hand curve. The results were so surprising the tests were repeated with a larger slip speed. In order to obtain the latter the headplates were removed from the blower and more red lead was put into the joint. The right-hand curve was obtained from this test. It will be seen that the character of both curves is exactly the same. The length and shape of the inlet pipe were varied and the location of the pressure gage on the outlet was changed; but these changes had no appreciable influence on the shape of the characteristic curves. In these tests the discharge pressure was five pounds per square inch. At lower pressures the slip speed is much less.

The actual delivery falls below the probable delivery at lower speeds and rises above it at higher speeds. Vibrations of the air column undoubtedly explain this peculiarity. At low speeds the whole column is accelerated and retarded, but as the speed increases the inertia of the column causes vibrations of a sound-wave character to appear. At certain speeds, the phase of these vibrations corresponds with the opening of the blower to the suction and an extra quantity of air is shoved into the blower, thus increasing the delivery. This case is parallel to that of blowing engines with air-intake pipes and automatic-inlet valves where the delivery is likewise increased by the inertia of the air in the intake pipe.

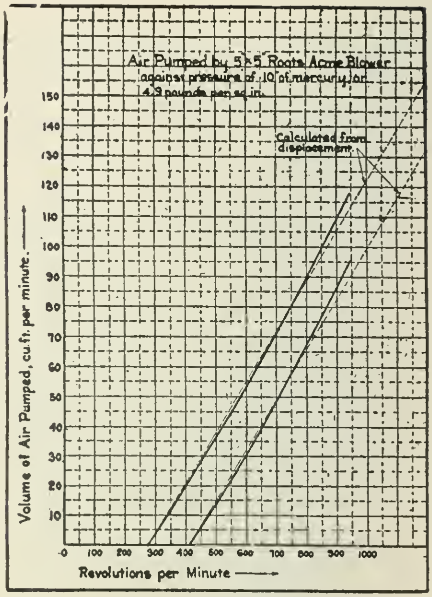
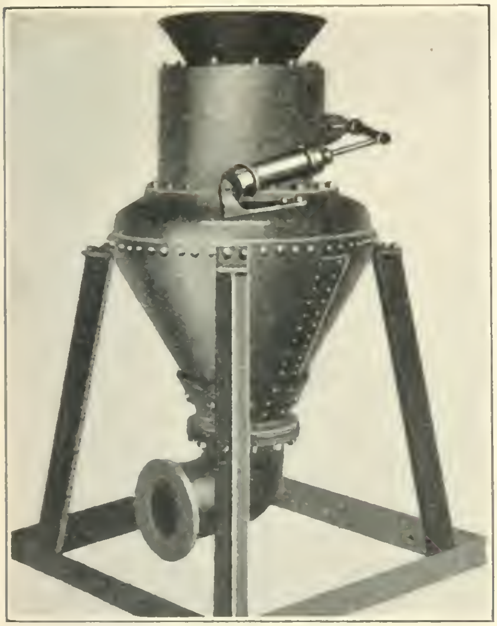


FIG. 2

Vibrations have a phase-lag against the impressed vibration of the blower. This may explain why attempts to furnish an engine torque coinciding with the static torque of the blower have not been successful. Vibrations occur not only in the intake but also in the discharge pipe. It has been thought that perhaps at high speeds these vibrations might become destructive. It is true that vibrations increase with the speed but only up to the point where they become sound-waves. Above this speed the pitch of the sound, i. e., frequency of vibration, increases; but the amplitude, i. e., loudness, remains constant. The maximum vibration depends upon the ratio of outlet-pipe size to fluctuation of displacement. The smaller the outlet pipe for a given blower, the worse the vibration becomes. With the average size of outlet pipe the vibration to either side from mean does not exceed 10 per cent. of the absolute average outlet pressure. In unusually long pipes, however, resonance might increase this somewhat.



CONCRETE MIXER

DETAILS OF PNEUMATIC CONCRETING

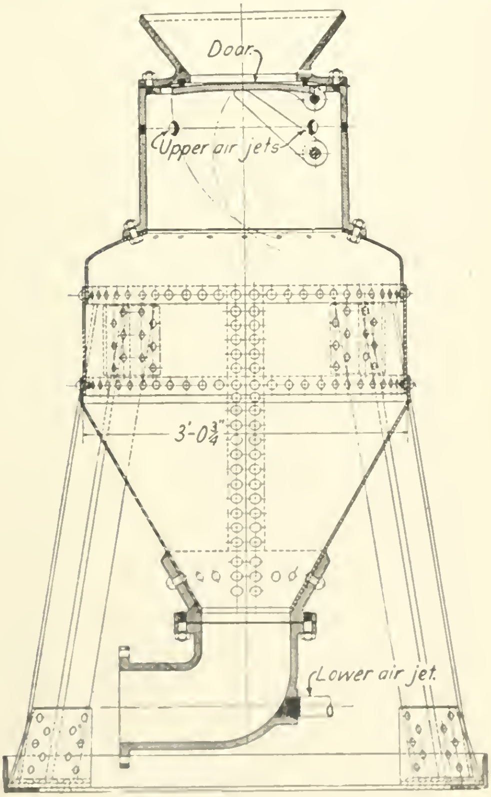
By H. B. Kirkland*

The pneumatic method of mixing, conveying and placing concrete is a comparatively recent development in engineering methods of construction. This method should not be confused with the cement gun process, which is a plastering process and is entirely different in operation and purpose. Both methods are patented. The pneumatic method is adapted for heavy, difficult concrete work, using ordinary ingredients with aggregates up to 4 or 4½ in. diameter.

Briefly described, this method consists simply in blowing batches of concrete through a pipe from a central point of supplies to their place in the concrete forms. The materials for a batch of concrete (1½ cu. yd.) are proportioned in a measuring device and dropped into the pneumatic mixer without previous mixture.

EQUIPMENT

The plant for pneumatic mixing and placing consists of a mixer, a pipe conveying system and a compressed air plant. The mixer consists of a steel shell having the shape of an inverted cone surmounted by a cast steel cylinder in which a door is operated by a small air piston. The door is opened by releasing the air in the cylinder, allowing it to drop open by its weight. At the bottom of the inverted cone chamber is a 90-deg. elbow which forms the connection to the discharge pipe. The door and piston is the only moving part of the mixer and the inside contains no mechanical mixing apparatus and is entirely smooth and free from obstructions. An air jet located at the heel of the bottom elbow of the mixer is the prime means of conveying and mixing the concrete. It is supplemented by other air jets located at the top of the mixer. The main air jet is directed into the center of the discharge pipe where it catches the material as it falls from the cone-shaped hopper above. The upper air jets create a pressure from above the batch, forcing it downward into the discharge pipe where it is caught by the main jet. To admit air to the mixer, two valves are used, one located on the air supply



CONCRETE MIXER IN SECTION

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*Abstract, Western Society of Engineers.

line leading to the lower jet and the other on the line leading to the upper jets placed above the level of the batch.

THE OPERATION

In operating, after the batch containing cement, aggregate and water is placed in the mixer, the door is closed and the main jet is opened. This is followed by opening the valve to the upper air jets. Many operators very this method but the effect of this sequence of control is to start the batch forward at the bottom of the machine, detaching successive portions of the batch at the tip of the cone. The materials in the mixer flow downward in the same manner that sand flows from the upper chamber of an hour-glass, but the speed of the flow is accelerated by the air pressure.

The conveying pipe consists of any standard smooth steel pipe with joints made with bolted flanges or any type most easily and rapidly handled in making connections. The most rapid wear on the pipe occurs at the points where there is apt to be a slight irregularity or a shoulder. Threaded pipe is also thinner where the threads are cut and of course wears through there first. For making deflections of the pipe line, cast elbows are used. An ordinary cast iron elbow will last sometimes less than a day, but a case-hardened steel elbow will usually last a few weeks. The best elbow is cast manganese, which will almost outlast the pipe itself. These elbows are made in 45 deg. with a thickness of ⅝ in. on the inner curve and ⅞ in. thickness on the outer curve. This gives a weight of about 220 lb. for an 8-in. elbow. The radius of the elbow is 3 ft. minimum, as a shorter radius is too sharp a turn and causes plugs in the line. Shorter radius elbows may be used however, at the discharge end of the pipe. A split elbow of 90 deg. has also been used for 6-in. pipe. This elbow is split lengthwise so that the outer half of the curve which usually wears rapidly may be replaced.

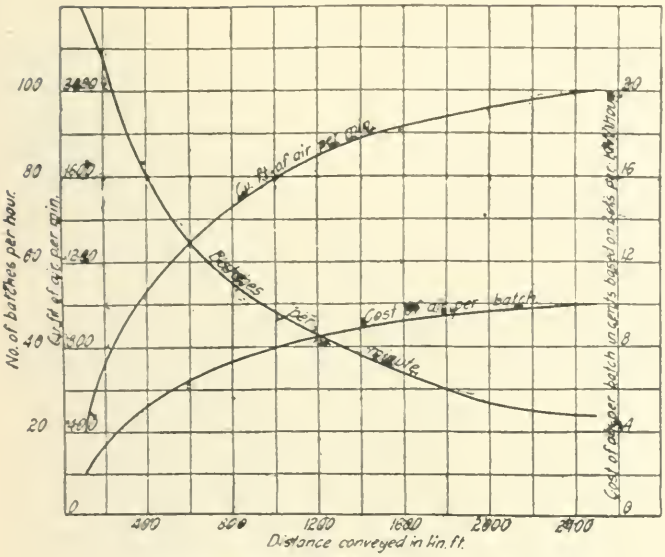
A means of deflecting or guiding the discharge of concrete in the forms consists of a series of slightly tapered pipes, fitting together like stovepipe. Two or three sections of this light pipe about three or four feet long are all that are needed in a tunnel form for diverting the discharge from one side wall to the other and for guiding the concrete discharge around points of rock projecting from the roof. Where the tunnel is very wide, however, as in a double track railroad tunnel, a wye branch is used in the line, so there are two lines of pipe entering the tunnel form. A side valve or gate is placed in the wye for diverting the batches through one line or the other.

THE COMPRESSOR

A compressor of suitable type is employed, the one ordinarily selected being a straight-line, one-or-two-stage machine, compressing from 80 to 125 lb. The drive may be steam, oil or electricity as may be cheapest, most convenient, or most economical. It is desirable to locate the plant near the mixer, but it is quite necessary to provide air storage close to the mixer sufficient at least to store enough air to discharge a batch of concrete at the maximum distance required. This storage should be at least 100 ft. capacity with 30 cu. ft. capacity added for each 100 ft. of pipe line. There should be additional storage at the compressor if the mixer is located a considerable distance away (for example, more than 300 ft. away).

The amount of air required to convey concrete depends upon the specific gravity of the materials, the smoothness of the pipe, the number of bends in the pipe line and their radii, the distance conveyed vertically and horizontally and upon the pressure or velocity of the air used. For the standard size mixer this is about 2 cu. ft. of actual free air compressed to 100 lb. per sq. in. per lin. ft. of pipe per batch. In other words, to convey one batch 500 ft. it will take 1,000 cu. ft. of actual free air compressed to 100 lb.

Based upon this figure, the diagram shows the amount of air required to convey concrete at various distances. This curve is based upon practical observations on a number of jobs, and certain assumptions have also been made in order to complete the figures. It is assumed in this curve that certain conditions of the concrete operations are as follows: 20 sec. are allowed for opening the door and charging the mixer after each batch has been discharged and the air valves closed; 5 sec. are taken as the length of time to convey a batch each 100-ft. and as the distance becomes greater the number of batches per hour decreases until at 2,500 ft. the number is 24, and the amount of air at this distance is 2,000 cu. ft. per min. It should be borne in mind that



AIR REQUIREMENTS FOR CONVEYING CONCRETE

if it is desired to get the maximum output possible the capacity of the compressor should be great enough to build up the air pressure in the storage tank in the time required to shoot a batch.

THE MIXING PROCESS

One of the first questions asked by the engineer is, "How is the concrete mixed?" This is explained by a study of the conditions which affect the batch from the time it is placed in the mixer until it is delivered in place in the forms.

In loading the mixer the ingredients, cement and water, are usually placed in a measuring hopper, so that when the hopper is emptied into the mixer the first commingling of the ingredients takes place. The first commingling is not particularly important, as it is very slight. When the air is turned on that portion of the batch which is at the bottom of the mixer, in front of the conveying air jet, is first to move and is instantaneously followed by portions dropping from above. As the mixer has the shape of an hour glass, the central portion of the batch in the mixer flows down first, and the portion in the sides follows in the stream from the upper part, exactly as sand flows in an hour glass. During this operation the mingling of the different ingredient parts causes the smaller ingredients to flow into the voids between the larger ingredients. As the portions of the batch drop into the lower air stream, which has a velocity of about 5,000 ft. per sec., these portions are carried along in suspension much as dust is carried along in a storm, except that the particles are much closer together. Although the speed of the air jet is very high, the speed of the concrete materials is much lower. The speed of the concrete varies according to the amount of voids in the materials which permit the air to pass through. The air in passing through tends to carry with it the smaller ingredients; that is, the sand tends to fill the voids between the rocks and the cement tends to fill the voids remaining, and, as the voids become filled up with the smaller ingredients passing through, the speed of the mass increases, the pressure of the air behind the mass increases with the decrease of the voids in the mass, and the speed of the mass concrete increases.

Now, in this explanation of the mixing process, I have assumed that the air velocity passing through the pipe is sufficient to keep the materials in suspension, and it is important to have a sufficient air pressure to keep the materials in suspension, because when the air velocity is reduced the materials simply roll and tumble along the bottom of the pipe. The concrete will also mix in this manner, but it is not conducive to good operation and makes a dirty pipe line, which is liable to become plugged. In shooting concrete, therefore, it will be found that with an 8-in. pipe and with materials of the specific gravity of limestone, the pressure should not fall below 50 lb. per sq. in., as the materials will then commence to drag along the pipe. Any air expended below 25 lb. is wasted when blowing concrete through an 8-in. pipe.

Three general types of pneumatic installations have been developed through the requirements of different classes of work. These are central plant or scheme of locating the mixer at a central point from which the conveyor pipe is laid to the forms, portable plant or outfit upon which the mixer is carried and is either loaded from bins carried on the same conveyance or supplied by a belt or other loading device, and the scheme of loading the mixer at various points as at the bottom of manholes in shallow tunnels and supplying it with materials through a chute from the various corresponding points along the surface. The last is a form of central plant made semi-portable.

DRIVING A TUNNEL UNDER AIR PRESSURE AND FILLING IT SOLID WITH CONCRETE.

In order to stop a heavy leak which threatened the ultimate undermining and destruction of Lock No. 3 on the Cayuga and Seneca Canal at Seneca Falls, N. Y., a tunnel was driven under compressed air beneath the walls of the lock, the leak located in a bad stratum of rock and effectively checked with a concrete cutoff wall. The small size of this tunnel, 4x6 ft. net section, required special equipment for handling muck and concrete. On account of the large volume of the leak a heavy battery of boilers and compressor equipment had to be ready for emergency service at all times.

The methods employed permitted the completion of the job without interfering with the water level in the canal.

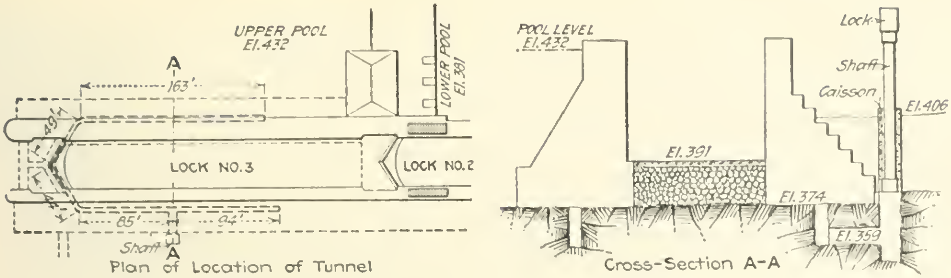
The Cayuga and Seneca Canal is a branch feeder of the New York State Barge Canal It connects the northerly ends of Canandaigua Lake, Seneca Lake and Cayuga Lake, and empties into the Barge Canal at Montezuma, N. Y. At Seneca Falls, between Seneca Lake and Cayuga Lake, is a dam with a power house and twin locks, Nos. 2 and 3. These twin locks have a combined lift of 51 feet from El. 381 to El. 432 above mean sea level. Lock No. 3, which is the upper of the two, has a lift of 39 feet.

Shortly after completion of the locks and filling of the upper pool, a leak showed itself when the water was lowered in the chamber of lock No. 3. The leakage increased until it became too great to be carried by the weep holes in a two-foot concrete bottom which had been laid in the lock chamber to prevent scouring. This bottom would not resist the pressure of the head of water which it had to stand when the lock was empty, and was forced upward in several places.

Early in the spring of 1917 it was estimated that the leak amounted to about 70 cu. ft. per second, and seemed to be increasing. It was decided by state engineers that it was necessary to repair the leak to prevent undermining and destruction of the locks. It then became a problem to determine the general locality of the leak. The flow of water showed in several places in the lock chamber, but as these places were the points where the floor had been upheaved they determined nothing. There was also a leakage out through the ground behind the land wall of lock, the ground level there being about 26 feet below the level of the upper pool. This led the engineers to think that the leak was through some particular stratum of rock below the bottoms of the lock walls. The walls from one end to the other were not founded on the same stratum of rock. Profiles of the rock showed that the concrete had been placed on a surface at about El. 374 for about half the length of the walls from the upper ends and on a surface at about El. 362 for the lower ends of walls, there being an abrupt drop from El. 374 to 362. In making this drop several strata of rock had been crossed, one of which the engineers knew to be of poor quality. It then seemed the most plausible assumption that the leak would be found in this stratum of poor quality rock and at the drop in the bottoms of the concrete walls.

Methods of grouting were considered, but discarded for something more definite. It was decided to drive a tunnel under compressed air beneath the walls of the lock at about the elevation of this stratum of rock of poor quality. By this method it was thought the leak would be located, and if the tunnel was then filled with concrete would provide a cutoff wall under the main walls of the lock.

A reinforced-concrete caisson 8 ft. 4 in. x 9 ft. 4 in. containing horseshoe shaped collapsible steel shafting was built up and sunk behind the land wall of the lock as near the upper end as practicable. This caisson was sunk from the ground elevation behind the wall, which was 406, to rock at El. 372. A hole 8 ft. square was excavated in the rock down to El. 353. When sunk, the top of the caisson was about 5 ft. above the ground.



PLAN AND SECTION OF TUNNEL UNDER LOCK WALLS

The steel shafting was raised to hold the air lock above the elevation of the upper pool. This made a shaft 89 ft. in depth from top door of air lock to bootom of pit excavated in the rock. From this shaft an entrance tunnel, 8 ft. wide and 6 ft. high, with bottom at El. 359, was driven a distance of 26 ft. toward the lock chamber. This distance reached a point beneath the center of the south wall of lock.

The main tunnel was then driven both east and west from the end of this entrance tunnel. The east branch was driven 94 ft. until it reached the step in the base of the concrete lock wall. The west branch was driven 85 ft. to a point opposite the intersection of the upper breast wall with the south lock wall. An angle of 60 degrees, a course of 45 ft., an angle of 60 degrees and a course of 49 ft., and another angle of 60 degrees carried the tunnel around under the upper breast wall and started down the north wall of lock. The tunnel was then driven 163 ft. to the step in the base of concrete of north wall.

Specifications called for a tunnel 4 ft. wide and 6 ft. high, but it was difficult to blast rock in so small a hole and it broke more nearly 5 ft. wide and 7 ft. high. During the driving of the tunnel some pockets of poor material and some small leaks were encountered, but nothing to make so great a leak as was indicated by the disturbance of the water in the lock chamber.

The roof of the tunnel being at El. 366, there was about 8 ft. of rock between it and the bottom of the concrete walls, 374 being the mean elevation of the bottom. A series of test holes 8 ft. apart were drilled in this rock overhead. They indicated readily that the leak was passing through a porous seam of material just underlying the concrete walls. Pipes were fitted in these test holes and grout was forced into them under pressure until they refused to take more.

The test holes showed that the main leak was located directly under the walls at the intersection of the upper miter sill and the outside or north wall of lock. A little different procedure was used in the case of this main leak to insure only proper results. The lock chamber was filled, thus equalizing the pressure on both sides of the wall under which the leak was located. This stopped any flow of water through the channel of the leak. About 300 bbl. of cement were required to grout the holes which led into this channel. After grouting, the pressure on the north wall was kept equalized for five days. At the end of this time when the water was lowered there was no evidence of any leak, showing that the grout had done its work.

The next step was to remove the rock overhead and extend the top of the tunnel to the base of the original concrete walls and fill the tunnel with concrete, making a cutoff wall. Beginning at the farthest end of the tunnel, a section about 30 ft. long of the rock overhead was taken down and the space filled with concrete to make a cutoff wall. Beginning at the farthest end of the tunnel, a section about 30 ft. long of the rock overhead was taken down and the space filled with concrete. In placing concrete the old benching method was used.

After the first section had been filled a different method was adopted for taking down the overhead rock and filling with concrete. There was about 8 ft. of rock to come down. On account of the narrow width of tunnel, this was too much to be taken down with one round of drilling and blasting. Four feet of it was taken down and a 6-ft. bench of concrete placed. This made a platform from which to work to take down the remaining 4 ft. of rock.

In the top bench of concrete, pipes were placed for grouting. Pipe No. 1 led from the bulkhead at the front end of the section to a point at the roof near the back end. Pipe No. 2, with an elbow and short nipple, led from the bulkhead to a pothole shot in the roof near the front end of section. After the top bench of concrete was placed as close up to the roof of the tunnel as was practicable and allowed to set for 24 hr., the grouting machine was hooked up to pipe No. 1, and grout was forced through this pipe until it filled the joint between the old and new concrete, rose up in the pothole, and was forced out the vent pipe No. 2. This insured a tight joint on the top of the cutoff wall. This method of taking down the rock overhead, filling with concrete and grouting the joint in sections was followed until the tunnel was filled.

When the rock was taken down at the intersection of the upper miter sill and the north wall, the cross sectional area of what had been the channel of the main leak and had been filled with grout was clearly shown. It was an area shaped like the segment of a large circle with a chord length of 11 ft. and middle ordinate of 27 in. The grout which filled the opening was solid and free of anything foreign, showing that the leak had a clear channel of 12 sq. ft. cross-sectional area.

Both for excavation and concreting the material was handled in dump cars specially built for this tunnel. Trucks of 24-in. gage flat cars were surmounted by wooden bodies of ½ cu. yd. capacity hinged under the middle for dumping. There was a 24-in. gage track laid the full length of the tunnel with a turntable at the intersection of the entrance tunnel with the main tunnel under the south wall. The bottom of the shaft being 6 ft. lower than the bottom of tunnel permitted dumping the cars of muck directly into the caisson bucket handled by a derrick at top of shaft. When concreting, an inclined platform was set up in the shaft about 5 ft. above the bottom of tunnel. Concrete was dumped from the bucket, handled by derrick on the platform, and thence moved by gravity into the car.

The contracting firm was well equipped with plant for this piece of work. There being but one shaft, only one derrick was required for handling labor and material in and out of the tunnel. Another derrick was set for unloading coal and handling sand and gravel direct from barges to mixer. Temporary buildings consisted of boiler house, compressor house, sandhog house, storeroom, cement house, blacksmith shop, pipe fitters' shanty and office.

The power plant was uncommonly good. Three locomotive boilers totalling 300 hp. were set up in battery and one 80-hp. boiler laid outside in case it should be needed. Three large low-pressure air compressors and one medium size high-pressure machine were set and ready for action on short notice. One of these low-pressure machines furnished air for the tunnel during almost the entire job. Occasionally a leak was encountered that required two compressors for short periods.

The box for the shaft caisson was ditched about 8 ft. in the open before the air lock was placed. Air was turned on Aug. 2, 1917. The shaft was built up and sunk 26 ft. through broken shale and 19 ft. through rock, a tunnel 6 ft. x 8 ft. was driven 26 ft. The main tunnel, 5 ft. wide with average height of 14 ft., was driven 486 ft. in shape of a horseshoe. Leaks were grouted and stopped, tunnels were filled with concrete, and air was taken off Dec. 18, 1917. Eight days of this time was chargeable to work on an additional spur tunnel not included in the original contract. Counting out these eight days, air should have been taken off Dec. 10, 1917.

The work was done by the Foundation Company, under the direction of W. B. Taylor, district manager for the company in that territory. The writer was superintendent in charge of the work. The State of New York was represented by H. C. Smith as resident engineer and C. H. Swick and L. W. Bently as inspectors on the work.—*Engineering News-Record.*

HOW PNEUMATIC TIE TAMPING PAYS

The United Railroads of San Francisco recently tried out and adopted a pneumatic tie-tamping outfit which has been found to afford a saving in cost and labor. As careful records were kept of items entering into both hand and pneumatic tamping methods it has been possible to compare the two methods in detail.

The equipment used is an 8-in. by 6-in. In-

TABLE I.—COSTS WITH HAND TAMPING

Labor	$0.257 per foot of single track
Tools, superintendence and overhead	0.017 per foot of single track
Total	$0.274 per foot of single track
Or $1,446.70 per mile.	

TABLE II—COSTS WITH PNEUMATIC TAMPING

Labor, including moving	$0.117 per foot of single track
Current	0.011 per foot of single track
Maintenance, oils, superintendence and overhead	0.010 per foot of single track
Depreciation and interest	0.006 per foot of single track
Total	$0.144 per foot of single track
Or $760.30 per mile.	

gersoll-Rand ER-1 compressor which has a piston displacement of 94 cu. ft. per minute. This compressor, sufficient for the operation of four tools, is driven by a 20-hp. motor operated by connection between trolley and rail.

An average of seven jobs in which 2692 ft. of single track was ballasted with hand tamping gave the figures as to this cost given in Table I.

Based on the same wage conditions and on the same track, namely 6-in. by 8-in. ties, 8 ft. long on 2-ft. centers, the costs shown in Table II were found typical for pneumatic tamping. These figures being based on a crew of seven men and four tampers making 180 ft. of single track per day.

Thus the saving effected by the pneumatic equipment amounts to about $686.40 per mile of single track. It is believed that a more compact roadbed can be secured by this method. Moreover, the fact that labor required is more than cut in half is considered a strong point in favor of the pneumatic method in times when the labor problem is acute.

The work on the United Railroad properties is under the direction of B. P. Legare, chief engineer of maintenance of way and construction.—*Electric Railway Journal.*

COMPRESSED AIR IN THE FURNITURE FACTORY

During the last few years, since wages have been going up and finishers have been becoming scarcer, most up-to-date factories have put in sprayers in the finishing room, also rubbing machines which are run by compressed air. Now, when a firm goes to the expense of putting in an air compressor and tank, the outfit may as well be made to do more than simply supply the finishing room. In our factory we have put it to use in the machine shop as well.

We run a ¼-in. pipeline from the compressor to our band saw, and use it as a blower for brazing saws. It gives so much stronger flame than the ordinary blower that we also use it for tempering all shaper knives. We also have a pipeline to our three-drum sander and a 30-ft. hose attached to it, which we use for blowing the dust off the machine. Formerly it took a man from ¼ to ½-hr. to clean up the sander with a duster; now he can do it easily in five minutes and do it much better, as it cleans out all the corners. The hose connection to the pipe is just in front of a window, so we use the same hose outside, to inflate the tires of our autos.—*The Woodworker.*

TORCRETE

"Torcrete" is a reinforced concrete specially prepared for ship construction and is said to bear about the same relation to ordinary concrete as rolled steel does to cast iron. Instead of being poured in forms the materials are shot in place by means of compressed air with the "tector," a new type of concrete blower. The processes are the invention of a Mr. Weber. The preparation is discharged on layers of steel fabric or wire mesh, and there may be as many layers as is necessary to produce the required thickness, the layers themselves massing with one another so as to form a perfect solid. It is claimed the torcrete vessels are lighter than wooden ships, built in shorter time and at lower cost than any other type of concrete ships, and that the method of construction is adapted to any size of craft or any form of metal that may be desired. A vessel of 3200 tons displacement has been contracted for by the Southern Oil and Transportation Company.—Philadelphia *Public Ledger.*

THE ARGUMENT FOR THE ONE-MAN DRILL

By J. Parke Channing*

About ten years ago I started to develop a low-grade copper mine in Arizona. As mine superintendent I had N. Oliver Lawton, a member of this Institute, whose experience at Lake Superior has made him familiar with what is known as the one-man air-drill. This is a light machine weighing about 125 lb., which can be readily set up and operated by one man. We started to use these in Arizona where, before, nothing but the larger and heavier machine, requiring two men, was in use. There was an immediate opposition from the men and we were accused of trying to throw half the normal number of miners out of work. Whenever I went through the mine I took the opportunity to tell the men that this orebody, up to that time, had not been considered 'ore,' that it was 'rock,' and that nobody thought it was worth exploiting; that far from throwing one man out of work, we were giving two men jobs, that if two men had to work on a drill the cost of mining would be so high that the material would not be ore, but that if we gave each man a drill and put him to work in a separate drift, then the rock would become ore, that these men would have employment and that a new industry would be started. About three months of this propaganda convinced the men of the truth of our claim, and in a short time it would have been impossible to get the men to go back to the old two-man drill because each man now felt that he stood on his own feet and got credit for the whole distance he drifted. This is only one example, but it indicates what can be done by education. The old-time manager or old-time superintendent would simply have said, take the job or leave it; but this is not the attitude for the modern engineer.

COMPRESSED AIR IN ELECTRIC STATIONS

Compressed air is frequently employed for blowing out switchboards, and the apparatus mounted upon them. For the rear of the board a pressure between 50 and 80 pounds per square inch suffices for removing dust from conductors, oil switches, rheostats, and so forth. The nozzle of the hose should be insulated, of course, so that there is no possibility of causing short-circuits or shock to the operator. Compressed air may also be used for the front of the board, for blowing round meters, switches, etc. However, for the front it is often considered better to use a bellows rather than high-pressure air. With a bellows it is permissible to remove the glass covers of relays and meter covers and blow gently, thus removing dust that insists on settling. The valves of overload bellows-type relays may also be cleaned in this way, at which time it is good practice to determine the workability of the relay. High-pressure air should not be used for these purposes, as meters would be damaged and there is also likelihood of dirt being blown into the valves of relays, obstructing them, and making them unworkable. In a station there is a place for both high and low pressure air, and each should be used only in its place.—*Electrical Review.*

PNEUMATIC DOOR CONTROL

With the advent of women in ever-increasing numbers as conductors on electric cars, devices that contribute to ease of operation of cars are finding a wider market and readier sale. An illustration of this is furnished by air door engines, as they are described by one manufacturer; and pneumatic door and step control by another. The engines or controls save in energy consumption, because stops are shortened through faster opening and closing of doors. Where women are employed on one-man cars the closing or opening of heavy car doors and the dropping or raising of weighty steps by mechanical means is being seriously considered. Because one important Eastern road had placed 250 pneumatic engines on its subway cars, the employment of women guards has proved easy. The same company also has 100 surface cars so equipped and operated largely by women conductors. Simply by touching a push button the door engine, which can be adjusted for any speed of travel desired, is operated without the slightest physical effort. As further proof of their utility and popularity, these door controls or engines are being introduced on the leading traction systems all over the country.—*Electric Railway Journal.*

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*From address at meeting of Boston section. American Institute of Mining Engineers.

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EVERYTHING PNEUMATIC

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FOR FAIR PLAY FOR THE MAIL TUBES

Possibly it has never been suggested that Nero fiddled while Rome was burning because he could fiddle better then than under any other conditions. In these desperate times when catastrophies are occurring with which the burning of Rome is not to be compared, trivialities are indulged in which delay the consideration of the serious matters that confront us.

The pneumatic tubes in the post offices of the large cities have undoubtedly made good, have demonstrated their practical value by years of service. They should not be kept in a state of siege and it should not be necessary to continually watch and defend them. The following, from the *Congressional Record,* is presented in defence of the tubes, as economical and efficient accelerators of business, by Representative Steenerson of the Joint Congressional Tube Commission:

We went to work as best we could and spent weeks in examining into these matters, and held hearings in all these cities, and visited them all. Of course we supposed that when the dispute between the Department and these cities about this service was referred to the Tube Commission, which was created by law—a law signed by the President—that that should have some sort of effect to show that the Tube Commission was a sort of tribunal authorized to settle the dispute between the Department and the people who ordered the service and we went to work in good faith to make a report as to the quality of the service, whether it expedited the mail, whether it was safe and whether it was worth the money. And while we were considering that question the Department—while the question was pending before the Tube Commission—issued its annual report, in which it condemned the whole service and said it was not worth anything and that it should be discarded, thereby contradicting the report of the year before, where, basing their statement on the reports of their own experts, they recommended that the tube service should be continued in New York from Forty-second street down, a distance of more than thirteen miles, and basing their action upon the recommendations of the same men who made that expert report, came before the Post Office Committee of the House and asked for an appropriation to continue the New York tube service.

Now, if, as they have lately claimed, the tube service is unsafe, if it damages the mail, if it does not expedite the mail, if it is not efficient, why in the world did these same experts that are held up to us as the only men who know anything about the business recommend the continuance of the tube service in New York city?

There is an area in that congested city that is more crowded than any other city in the world. Take Fifth avenue, they say, from Forty-second street. Mr. Myers, the chief of traffic police, says from Fifty-fifth street down, or on Broadway, there are more foot passengers and more vehicles passing than in any other place in the world. Even in the city of London, around Trafalgar Square, or the Strand, or Pall Mall, or Piccadilly, or anywhere you cannot find any such crowded condition as you find in this congested district in the city of New York.

A year and a half ago these experts recommended that the tube service be continued there. But now they come around and say that the tube service is not worth anything, that it is junk, that it is no good, and should be abandoned everywhere. They wanted to put in a service that is unsafe, slow, unreliable, in the most thickly populated section in the world. They have criticised the Tube Commission for not paying sufficient heed to postal experts. This subject is city transportation. It is a subject that must be learned from actual experience and observation. Mr. Koons, Mr. Gardner, Mr. Johnston and Mr. Mullen were post office inspectors. It has been their duty to ferret out crime. They were detectives. Their work in no way qualified them as experts in this matter. The only man who had had any experience in city transportation was Mr. Ryan, who for a short time had been superintendent of mails in Philadelphia. Mr. Gardner, however, would not sign the report—refused to sign it—disagreed with the rest. These other three inspectors have claimed that they knew all about the subject, and that nobody else knew anything about it, and they have asked Congress to take on faith what they say about it. Evidently some people do. But the criticism that has been made upon the Tube Commission—that they did not consider the statements of the Department—is unfounded. The commission had before it the testimony of these experts before the House Committee and the Senate Committee.

Over in the House Committee the learned lawyer from Boston, Mr. Whipple, cross-examined the experts, and they did not come out so very well. Senator Bailey examined them. The secretary of the tube commission invited the department to submit their statements in writing, which they did, and those statements were printed in the report. All they had to say was printed without cross-examination. The object of cross-examination is to weaken the evidence of the witness. Yet they complain because we did not weaken the evidence of their experts by cross-examining them! We are glad to have omitted to call postal experts. How can you get postal experts outside of the Post Office Department? You must either take men who have been discharged or who have left the service. But there are business men who know a good deal about postal matters. The commission went to New York and they heard forty or fifty of the leading business men and representatives of business organizations, and, fortunately, we were able to get the man who, in my opinion, is the ablest postal expert on this subject that there is in the United States—Mr. Follmer. Mr. Follmer started in as an errand boy in the Postal Service, served 30 years, and advanced to be superintendent of delivery in the great city of New York. He had charge of the tube service and when the department last year proposed to change the tube service and to institute a Government-owned automobile service he was the man in the New York post office who was selected to lay out the schedules and the lines to operate the new automobile service. That shows that he was recognized by the department to be the most skilled man they had, so far as New York was concerned, and he did lay out those schedules and those routes. About six or eight months ago he was offered a position with the Bankers Trust Company to look after their mail. The Bankers Trust Company, one of the biggest financial institutions in the country, have very important financial mail to take care of, and they employed Mr. Follmer, so that at the time he was called before the commission he was not connected with the Postal Service and was free to give his opinion. I will insert his testimony in the *Record*.

We also had before us the testimony of ex-

Postmaster Morgan of New York, given before the House Committee at the hearing a year ago. I will insert that also in the *Record*. He strongly favored the continuance of the tube service. He was a real expert.

This testimony answers every objection that has been made by these claimed experts, who simply know by observation or information; but this is the testimony of a man who knew by actual experience, who had charge of the tube service. He says there is less in the way of accidents, less damage to the mail and greater expedition of the mail by the tube than by automobile, and it expedites the mail. That is a valuable thing in a large city like this, where $600,000,000 goes through the Clearing House every day, and 90 per cent. of that goes through the mails. If you send a check for $1,000,000 to a bank in New York, the customer is credited with, and it draws interest from the time the mail is delivered and the envelope opened and the check placed to his credit. . . . If you buy a large quantity of grain and pay for it with a check, if it takes longer to do that business, the expense of transacting the business is charged up in interest and the consumer has to pay it. That is the reason why every business man in New York and every other city says that if you delay the first class mail you touch the very nerves of business life. If you delay the financial transactions of this country, you delay the consummation of trade, and thereby increase the cost of living a great many times more than the whole postal service costs.

Mining methods in New York City—in new subways—vary considerably. In the sand and gravel strata, close timbering is necessary, with half sets. In hard-pan—gravel and clayey matter—a shield is used, this being pushed ahead as excavation proceeds. In rock—a schistgneiss—ordinary drilling and blasting methods are in vogue. Mining in the city is of far greater extent than generally thought and by the end of 1918 there will be 308 miles of subways. This does not involve the excavating of a small tunnel, but one the full width of a street and often wider. At the same time traffic on the surface must not be interfered with by the underground work. Eventually there will be 600 miles of underground lines, costing $400,000,000 in all—"and then some."

NEW BOOK

Mining Engineers Handbook written by a staff of Specialists under the Editorship of Robert Peele. New York, John Wiley & Sons, 2385 pages, 4¼ by 7 in., 3 in. thick, flexible covers, full gilt edges, crowded with pertinent cuts. $5.00 net.

Professor Peele's earlier book, "Compressed Air Plant," showed him to be careful and thorough, and the present work confirms the estimate. Five years ago, he says, the editor outlined the table of contents and invited a number of associate editors to contribute sections on their respective specialties. There are in the book 43 sections with the name of the responsible editor of each. There are, by the way, more than 8,000 items in the index. The book is not only compact with actual, usable information without theorizing, but also tells where to seek for more along the same lines. Notwithstanding the bulk of the work the matter contained is all immediately pertinent to the general subject of mines and mining presented in the most compact form. The only possible suggestion of padding in the book is about 30 pages of the tables which are in all the pocketbooks. It is not out of place to call attention to the low price of this bulky but beautifully printed book.

AN UNUSUAL AND FATAL COMPRESSOR ACCIDENT

A serious accident occurred at the storage warehouse of the Merchants Refrigerating Company, 16th and 17th Sts. and 10th Ave., New York City, May 18. At 7 P. M., according to the account in *Refrigerating World*, "a piston rod pulled out of one of the ammonia compressors while running at high speed and thrashed about, partially wrecking the machine." This, we confess, is to us entirely unintelligible. We would rather suggest that it was the connecting rod accidentally disconnected at the crosshead, which did the thrashing.

The remainder of the account is perfectly intelligible. "Relieved of its load the flywheel burst under the increased speed and the engineer was killed. Ammonia gas escaping from the compressor filled the machinery department. Emergency calls brought the fire department with gas helmets and pulmotors and the fire engines.

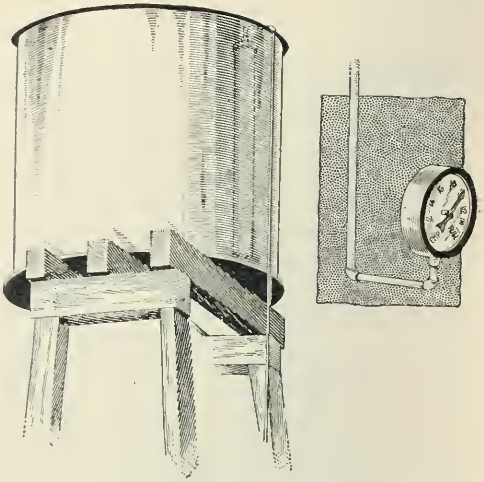
"A system of flushing the ammonia system into the sewer with water had at once been put into use after the accident and a vastly greater calamity was thus avoided, but the machinery department had been filled with explosive vapor mixtures. As there was no inflammable material in the basement we understand that the engineers present protested with the fire department against turning water into the premises but that was unavailing, the fire officials urging that the water would absorb the fumes. When the water was turned in, or very soon thereafter, a violent explosion occurred, believed to be due to the effect of the water in short-circuiting the electrical mains from which the plant was operated. The machinery was run entirely by electric current.

"Many firemen and soldiers guarding the barred zone, and others on the outside of the building were hurt by the fumes and the effects of the explosion, among them the company's chief engineer Wm. E. Berend. Owing to the late hour only the night crew was employed in the building, most of whom were out of the way of the explosion, the force of which, going up through the shaft carrying the brine pipes to the refrigerating rooms in sections above, blew many of the doors from their fastenings or wrenched them loose, or blew them open, and filled the rooms with smoke and fumes. Apart from the blowing out of these doors the damage to the house itself was insignificant, but refrigeration was shut off from the entire plant and the damage to goods stored was considerable."

A PNEUMATIC WATER LEVEL INDICATOR

An ingenious correspondent has sent to one of our most esteemed exchanges the sketch here reproduced—a photo would have been so much more convincing—with accompanying description as follows:

"A convenient water-level indicator for a remote water tank can be made as shown in the accompanying illustration. A 4-in. pipe is vertically installed in the tank, on top of which is screwed a 4 x ⅛-in. reducer, the bottom end of the pipe being left open and supported about an inch from the bottom of the tank. A line of ⅛-in. pipe is run to a convenient point and an old pressure gage attached to it. As the tank fills it is evident that the air entrapped in the 4-in. pipe cannot escape, hence it must undergo compression. As the amount of this compression depends on the height of the water level in the tank, the gage reading will thus increase as the water rises in the tank. A dial was placed on the old gage, and by experiment various heights in the tank are marked upon it as determined by trial. Where the tank is far from the gage, it is better to incline the big pipe in the tank, so that a greater volume of air is entrapped, thus making up for any drop in the small pipeline. Of course, it is a good plan to go up in the tank once a season and check up on the gage."



PROPOSED WATER LEVEL INDICATOR

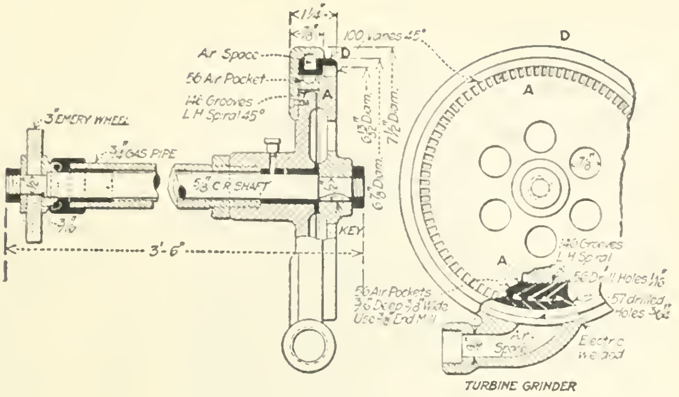
It should of course be unnecessary to remark that all the piping and connections should be absolutely and everlastingly leakless, and that the temperature of the enclosed air, and consequently that of the water in the tank, should never change. We are not told where a pressure gage with a range sufficiently minute could be obtained. Say that the total range of water level in the tank was 10 feet between highest and lowest, then the maximum difference of air pressure would be 4⅓ pounds. As the water rose or fell in the tank there would also be a change of level of the water in the pipe, and this would affect the indications.

AIR - TURBINE - DRIVEN GRINDING WHEEL

By W. J. Nene

One of the most pronounced difficulties associated with the electric welding of cast iron in the small shop is the tendency to leave the weld so hard as to be practically unworkable by any form of tool short of an abrasive wheel.

This is especially true when joining small parts to a larger body, where the mass of metal adjacent to the weld is sufficiently large to conduct the heat rapidly from the welding point; and with the usual perversity of inanimate things these hard spots are generally located at places most inaccessible to the ordinary form of grinding apparatus.



AIR DRIVEN GRINDING WHEEL

While this trouble may be minimized by the introduction of silicon by means of the welding rod or directly into the weld it has never been wholly eliminated, and to give the operator a quick and efficient means of working down these hard spots the grinding machine illustrated herewith has been devised.

This machine is simply an air turbine of special design, carrying an abrasive wheel on the end of its rotor shaft and combining simplicity of construction with lightness and ease of manipulation.

I do not claim originality in the application of the air turbine to the hand-grinding machine, but merely submit the following description and vouch for the machine's efficiency. The turbine furnishes ample power at 90 to 100 lb. pressure to drive a 3-in. wheel at 6500 r.p.m., which is approximately correct for a wheel of this size.

The machine as used for grinding welds is usually held in the operator's hands, and being well balanced there is practically no vibration except it be caused by wear of the grinding wheel during the actual grinding operation. It has also been used for internal, external and center grinding, being held in the tool-post of a lathe, and as a hand-polishing wheel for certain parts of locomotive side rods, etc.

All parts are made of mild-steel forgings except the ring *D* and the bearings, which are of hard brass, and the ball races, which are of tool steel hardened and ground. The air connection, or intake, was electrically welded in position after the other parts were machined.

The compressed air enters the annular chamber marked "air space" on the cut; thence flowing through the air ports (that is, the fifty-seven $^3/_{64}$-in. drilled holes) and impinging at high velocity on the air pockets in the rotor *A*, imparting to it the first rotary impulse. At this point the air divides, part flowing through the $^1/_{16}$-in. holes in the rotor and thence toward the center, where it exhausts through the six ⅞-in. holes, while a larger portion of the air flows through the $^1/_{64}$-in. opening between *A* and *D*, where it comes in contact with the vanes or wings which form part of the rotor and are set at an angle of 45 deg. with the axis of the rotor.

As the combined area of the 57 air ports is approximately 0.098 sq. in., a ⅜-in. air hose would furnish an ample supply of air, but the usual standard connection for small hose is ½-in., and for this reason the air intake of this machine is made of this size.

A feature of this turbine is that when running at full speed it seems to use very little air; in fact it is necessary to hold the hand quite close to the machine in order to feel the exhaust.—*American Machinist.*

ELABORATE AND COSTLY AIRPLANE EQUIPMENT

The following is abstracted from publications of U. S. Signal Corps:

Before an airplane can be put into military service it must be equipped with nine or more delicate aeronautic instruments, some of which are absolutely essential to exact flying, and all of which contribute to successful operation. Without them a pilot would soon lose his location as to height and direction; he would not know his speed through the air, the speed of his propeller, the amount of gasoline in his tank, the temperature of his cooling water, or if his oil was circulating. He could not tell whether he was banking properly on his turns.

These comprise the necessary flying instruments, but an aviator could not fly to any great height without another valuable instrument, an oxygen supplying apparatus, nor could he operate his guns, signal headquarters, release his bombs, or "shoot" his cameras without additional mechanisms.

All these instruments must be ready for installation as soon as the airplanes are assembled, for no plane is complete without them. In some instances, as for the two-seaters and the heavy bombing machines, two and even three of each sort are necessary, totaling sometimes as many as 23, but for ordinary work only about 9 are needed. The average cost of a set of navigation instruments for a single plane is $350.

For the operating of actual observing, photographing, bombing and fighting planes many other complicated and expensive instruments and sets of apparatus are necessary. Among them are machine guns, gun mounts, synchronizers, bomb racks, bomb dropping devices, bomb sights, radio, photographic and oxygen apparatus, electrically heated clothing, lights and flares. The cost of these additional accessories would bring the total cost of equipment up to several thousand dollars.

Various instruments have been developed or improved by the Signal Corps, including:

THE TACHOMETER

This instrument indicates the number of revolutions per minute at which the engine is running. Unlike the speedometer on an automobile, it does not translate revolutions into miles per hour; another instrument gives the speed in relation to the air. When instrument matters were taken up last July there were no tachometers manufactured in this country of the type which has proven most successful abroad; namely, the escapement or chromatic type.

THE AIR SPEED INDICATOR

This is a pressure gage for showing the speed of the plane in relation to the air, not the earth. This instrument includes what is known as a Venturi-Pitot tube, which is fastened to a strut and takes in the air from ahead. The air sets up a corresponding pressure in an auxiliary tube, which is calibrated and indicated on a dashboard recording pressure gauge.

THE ALTIMETER

The altimeter is an aneroid barometer, graduated to read height above the earth instead of pressure. Under standard specifications a reduction in weight and size was effected in the manufacture of these instruments, which are now being produced in large quantities and of a quality equal to the best foreign make. Three standard types are made with ranges of 20,000, 25,000 and 30,000 feet.

THE AIRPLANE COMPASS

After much experimental work this instrument has not yet reached the perfection desired. A new type, having advantages over any present form of compass, especially as to compactness, is now used. In the development of this instrument effort has been made to reduce the weight to the safest possible minimum and to decrease the space required in the airplane.

AIRPLANE CLOCKS

Due to the development which had been made in clocks for automobiles, it was only necessary to standardize a design of mounting in order to adopt such clocks to airplanes. Sufficient quantities are now available for all needs.

PRESSURE GAGES

Instrument-board pressure gages were already manufactured here in large quantities, and as soon as standard specifications were developed production started. Two types are used, one to register the air pressure which forces the gasoline to the engine and the other to show the pressure produced in the oiling system by the oil-circulating pump. Standard forms of cases and dials with interchangeable glasses and bezels have been designed.

THE RADIATOR THERMOMETER

This instrument is mounted on the instrument board, where it indicates the temperature of the cooling water in the engine. Undue heating shows that the engine is not running properly or that more water is needed. Thermometers of this type made here were, and still are, being submitted to extensive tests.

BANKING INDICATOR

This is an instrument used to show when a plane is correctly banked in making a turn.

Spirit level, balance, and gyroscopic types are being used. The problem of indicating the extent to which a plane is inclined to the horizontal in the air is a very complicated one. No simple solution has yet been reached. Fortunately, it is not often necessary to determine whether the plane is exactly horizontal, except in connection with bomb dropping. Development work is under way which it is hoped will lead to improvement of devices already in use abroad.

THE ALDIS SIGHT

This sight, which is used in connection with fixed guns firing through the propeller, has been copied, as regards its optical features, from an English instrument; but the construction has been modified in such a way that the behavior of the instrument in actual use will probably be very much improved. After a number of tests and experiments satisfactory instruments are now available. The makers have been assisted in recomputing the lenses to suit the optical glass available in this country. The illumination of these sights for night operation is also being studied.

FACTOR OF UNSAFETY

On a recent trip to a remote part of the state of California, one of the boiler inspectors of the Industrial Accident Commission found an installation which was, to say the least, unique. The boiler was of the vertical tubular type, 30 in. in diameter, and was fitted with a ball-and-lever safety valve. In addition to the ball weight, the lever carried four large-sized horseshoes. Upon inquiry it developed that the operator of the boiler thought he had a factor of safety of 5, since he carried only 40 lb. pressure, and the steam gage was graduated to 200 lb. Any idea that the horseshoes were a symbol of good luck, was soon dispelled by the inspector, who pointed out the grave danger of "loading" the safety valve.

PORTABLE PNEUMATIC WOOD PLANER

PNEUMATIC WOOD PLANER

The tool here shown in operation is one of a line of air planing machines manufactured by the Shipbuilders Pneumatic Tool Company, Portland, Oregon. The ready adaptability of this tool, especially in ship building work, is evident at once. It can be applied to surfaces to be planed anywhere and manipulated with perfect ease while often difficult or impossible to bring the work to a stationary machine. These planers are rotary machines operated by air driven turbines which run at 8,000 to 15,000 turns per minute. There is only one movable part and the cutters are easily removed for sharpening and reset. The amount of cut at each pass-over is instantly adjustable. In a trial of one of these machines at the Foundation Company's Portland plant a workman planed 385 square feet in five hours, while eight men with hand planes finished 275 square feet in seven hours.

FOG IN THE BOILER ROOM

By G. C. Derry

In a power plant at Port Henry, N. Y., on the shores of Lake Champlain, a troublesome vapor condition existed in cold weather from cold air coming in and condensing the moisture in the warm air in the boiler room, which caused a fog so dense that the firemen could scarcely see their steam gages and water glasses from the floor of the boiler room. Several plans for getting rid of the vapor were tried without success. The coal supply was just outside the boiler room, and there was a continual opening and closing of doors as the firemen brought the coal in. The fog was so dense, in fact, that when the firemen started in with the coal, they had to shout in order to avoid running into each other, and it was difficult to get men to stay and work under such conditions. Water tenders had to be put on in order to watch the water gages from an elevated platform constructed in front of the boilers.

A condition existed which resembled the blowing of one's breath into cold air in the winter time, and it seemed to me that the logical thing to do was to bring the incoming air up to the temperature of the room or possibly a little higher, so it could carry off some of the vapor. Proceeding along these lines, a large heater and multivane fan were installed which drew the air from the room, mixed it with some fresh air from outside and forced it through a duct system leading along the sides of the room and down each side of each door and up against the cold surface of the windows. The fan and heater were installed on an inclosed platform over the door which led to the coal pile, and advantage was taken of this platform—making it a ceiling of a room into which to pour a large amount of heated air.

The fan had a capacity of 33,000 cu. ft. of air per minute, and the air in the room was changed every three minutes. The heater was capable of heating this amount of air from 10 deg. to 158 deg. when supplied with steam at 60 lb. pressure. The system had the advantage of removing the steam in the winter and also providing a means of ventilation in the summer.

The owner has advised us that the system worked satisfactorily, removing every trace of the vapor even during the extremely cold weather last winter.—*Power*.

NOTES

A Boston hotel with a large electrical sign, when compelled to cut off its illumination under the Fuel Administration order prohibiting such uses of current, had the sign painted with luminous paint, which is said to be fairly satisfactory war-time substitute.

Approximately Fifty million car stops are made in the United States each day. The "skip-stop" schedule would eliminate one-third of these. The elimination of six billion stops a year, together with the regulation of car heating, will bring a fuel saving of not less than 1,500,000 tons of coal a year, which will meet the fuel needs of 300,000 average families.

The air compressor has become a very important factor in the production end of the retail monument shop. The compression of air for use in penumatic tools, air polishing machines and sand blast machines not only reduces the production cost of a monument, but it gives to the retail dealer a prestige which stamps him, in a way, as an up-and-coming business man.—*Granite, Marble and Bronze.*

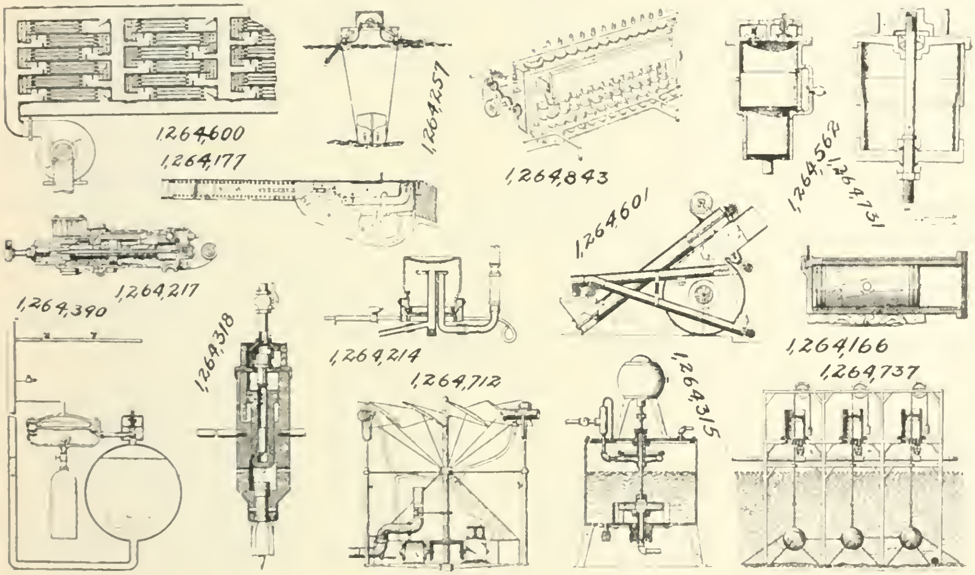
Compressed-air hoists, pumps, and drills are fast displacing steam-power in the Missouri-Kansas-Oklahoma zinc-lead region. As far as economy is concerned it has been demonstrated that with direct-connected gas-driven air-compressors the entire shaft-sinking equipment can be operated much more cheaply by air than with steam. The only reason why compressed air is not more favorably regarded and more generally employed is that proper precautions are not taken for draining the air and avoiding the freezing up of the exhausts.

Reinforced concrete for building walls is commonly mixed quite wet and is usually compacted by spading it. Concrete containing less water, and of a quaky rather than fluid consistence, is sometimes specified; but it cannot be tamped economically in thin reinforced walls. However, it can be compacted by striking the forms and the reinforcing bars with a light wooden maul. This suggests the possibility of using a pneumatic hammer for this purpose, for a large number of sharp light raps should be effective in causing the concrete to settle in the forms.

Cement and Sand—3 to 1 mixture—sprayed on mine timbers, by compressed air, renders them fire-resisting to a considerable degree. Any desired thickness may be built up by spraying in layers, by the cement gun.

Tearing up city streets in order to sell the paving material is being seriously considered by the city officials of Butte, Mont., according to advices from that city. A few years ago some of the streets were paved with manganese ore, which at that time was considered worthless. Since then the war has caused a heavy demand for manganese, and the manganese rock used for paving is now valuable.

According to authoritative figures the increase in the production of motor trucks during the first three months of 1918 amounted to 100 per cent. over the production a year ago. It is expected the total output of trucks for 1918 will represent a higher value than the output of passenger cars. The production is now on a basis of 310,000 trucks for this year at an average price of $2,000 or a total production figure of $620,000,000.



Pneumatic Patents April 30

The first man-carrying airplane flights were made in December, 1903, with the Wright Brothers' engine, developing 12 hp. and weighing 12.7 lb. per. hp. In 1910, seven years later, the average horsepower of aeronautic engines had increased to 54 and the weight decreased to 5.7 lb. per hp. In March, 1918, the Liberty 12 developed 432 hp. for a weight of 1.86 lb. hp. By May, 1918, the Liberty 12 was yielding a maximum of 450 hp. for a weight of 1.83 lb. per hp. The Langley-Manley engine, built in 1901, was nine years ahead of its time in the matter of power output and 16 years ahead in its weight per hp., developing 52 hp. and weighing 2.9 lb. per hp.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 30

1,264,166. AUTOMATIC CLOSING DEVICE FOR FIRE-DOORS. Albert G. Elvin, Somerville, N. J., and Frederick W. Martin, New York, N. Y.

1,264,177. AIR-GUN. William B. Greenleaf, Plymouth, Mich.

1,264,214. MILKING-MACHINE. Warren A. Shippert, Dixon, Ill.

1,264,217. ROCK-DRILL. William A. Smith, Denver, Colo.

1,264,257. APPARATUS FOR RAISING SUNKEN VESSELS. Walter C. Beckwith, Fostoria, Ohio.

3. In an apparatus for raising sunken vessels, a pair of pontoons, a framework carried by and connecting said pontoons, a deck upon the framework, windlasses supported by the pontoons, levers adapted by their rise and fall to actuate said windlasses, floats, carried by the levers, an air compressor connected with said floats, a conduit between the air-compressor and the floats, and means for the control of the ingress and egress of air and water to and from said floats.

1,264,315. COMBINED ASPIRATOR AND FORCE-PUMP. Edward F. McCarthy Chicago, Ill.

1,264,318. PNEUMATIC TOOL. John T. McGrath, Bloomington, Ill.

1,264,390. AUTOMATIC FIRE-EXTINGUISHING APPARATUS. John R. Hamilton, Yonkers, N. Y.

1,264,562. FLUID-COMPRESSOR. Edward A. Rix, Oakland, Cal.

1,264,600. METHOD OF AND APPARATUS FOR DEHYDRATING FRUITS, VEGETABLES, AND SIMILAR ARTICLES. George Hillard Benjamin, New York, N. Y.

1,264,601. CONVEYER. George Bernert, Milwaukee, Wis.

1. In a pneumatic grain conveyer, a casing having a blower fan therein, a trunk extending from the casing, a conveyer drum communicating with the trunk, means for preventing the accumulation of grain in the fan casing, and means for returning grain dropped in the fan casing to the conveyer drum.

1,264,995. BLOWER. John C. Swaykus and Alex Tracz, Lackawanna, N. Y.

1,265,002. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkensburg, Pa.

1,265,014. COTTON-SEED LINTER. James T. West, Rockingham, N. C.

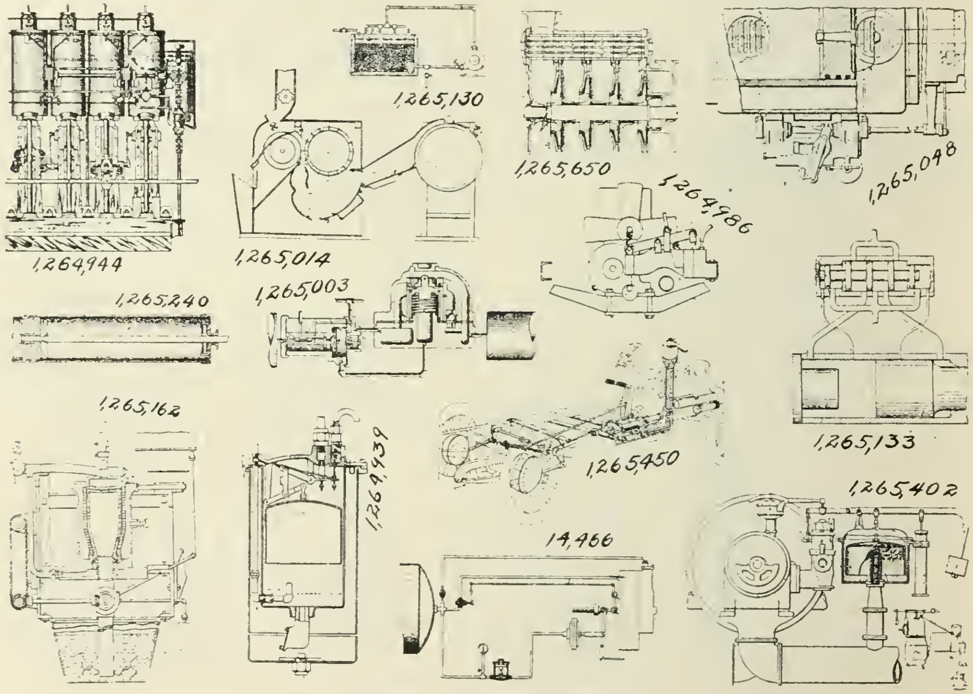
1,265,048. AIR-COMPRESSOR. Carl A. V. Carlsson, Washington, D. C.

1,265,130. PROCESS OF CURING OLIVES. Homer C. Staley, Hayward, Cal.

1. The process of curing olives which consists in subjecting the olives to a lye bath and subsequently subjecting the olives to a bath of continously artificially aerated circulating liquid.

1,265,133. ROCK-DRILL. Thomas E. Sturtevant, Dover, N. J.

1,265,162. PROCESS AND APPARATUS FOR MAKING BOTTLES FROM PAPER PULP. Harry C. Ayerst, Seattle, Wash.



PNEUMATIC PATENTS MAY 7

1,264,712. ARIAL APPARATUS. Howard P. Tweed, Denver, Colo.

1,264,731. PNEUMATIC DIE-CUSHION. Carl Willers and Nils O. Laurin, Chicago, Ill.

1,264,737. WAVE-POWER APPARATUS FOR COMPRESSING AIR. Lemuel D. Woods, Boston, Mass.

1,264,843-4. VACUUM SEALING APPARATUS. Edwin Norton, Paget West, Bermuda.

MAY 7

1,264,939. VACUUM LIQUID-FEED DEVICE FOR INTERNAL-COMBUSTION ENGINES. Webb Jay, Chicago, Ill.

1,264,958. LIQUID-FUEL-FEEDING APPARATUS. Robert C. Mitchell, Mount Vernon, N. Y.

1,264,986. TIRE-PUMP. Charles P. Skublin, Detroit, Mich.

1,264,994. AIR STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES. Henry W. Sumner, Winslow, Wash.

1,265,211. TIRE-PUMP. George Keith, Sheridan, Ill.

1,265,240. FORCE AIR-PUMP. Daniel M. Myers, Jefferson, Iowa.

1,265,450. FLUID-PRESSURE BRAKE SYSTEM. James A. Hicks, Cincinnati, Ohio.

1,265,482. GOVERNING MECHANISM FOR COMPRESSORS AND EXHAUSTERS. Sanford A. Moss, Lynn, Mass.

1,265,550. HUMIDIFIER. Albert W. Thompson, Fitchburg, and Edward W. Comfort, Winchester, Mass.

1,265,650. COOLING DEVICE IN MULTISTAGE CENTRIFUGAL COMPRESSORS. Benjamin Graemiger, Zurich, Switzerland.

14,466. RE-ISSUE. PNEUMATIC STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. Charles G. Eidson, Anniston Ala., Thomas Davis, Detroit Mich., and David E. Crouse, Auburn, N. Y.

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OUR ENGINEERS IN THE WAR

By Gen. William M. Black*

Engineering in warfare has always been essential, and it is even doubtful whether the science of engineering does not owe its birth to the works of war. An engineer myself, I would be the last to be-little the work of our profession. It is a matter of pride that the men of our profession, because of the nature of their employment in time of peace, are, of all the civil professions, most prepared to serve the country in war; but to serve the country adequately in war the engineer must add to his peace equipment for professional work. There would be a great amount of effort saved if our people recognized more clearly the existence of the technicalities of the profession of arms. The government in Washington is simply deluged with suggestions and so-called inventions for the winning of the war. The records show that about ninety-eight per cent. of all these are without military value and that time and labor have been thrown away by men eager to help but entirely ignorant of the history and conditions of warfare.

NUMBERS OF ENGINEERS IN THE SERVICE

The part which engineers are now playing in the war is a very great one. The records of the American Institute of Electrical Engineers show that out of a total membership of 9,370 there are 850 in the service, or 9.1 per cent of its roster. The American Society of Civil Engineers, with 8,573 active members, has 14⅓ per cent in the service. The American Institute of Mining Engineers has 10.4 per cent, and the American Society of Mechanical Engineers 10.1 per cent. But these records are not complete. At the outbreak of the present war there were in the Engineer Corps of the regular army about 300 officers and approximately 3,500 enlisted men. At the present time there are about 8,000 commissioned officers and 200,000 enlisted men, made up of men formerly engaged in works of an engineering character. It is probable that this does not represent much more than one-half of the number of the profession now serving in the army.

DETAILS OF WAR ENGINEERING

Let us consider the nature of the work of the engineer, passing from front to rear of the army. First in importance is the work of the sappers. They go before and remove obstacles, clearing away obstructions, building bridges and roads, making the trench systems complete, mining, providing light, water, lines for supply (light railways or roads) and military mapping. In this category enter practically all of the branches of the profession. Further to the rear are found the construction and operation of railways; road and bridge construction; the construction of veritable towns for supply depots, with all their accessories, drainage, sewerage, lighting and water supply; construction of quarters and of hospitals; and furthest to the rear; the construction of the ports of debarkation with their wharves, storehouses, railway lines, yards and shops, all with their sanitary systems. Separate from these activities, but necessary for their supply, are the forestry troops who turn the growing timber into lumber of the dimensions required for the various services. Locomotive and car-shops also are performing essential services. Topographic corps, sound-ranging corps and camouflage corps are also among the varied activities of the engineers.

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*From an address by the Chief of Engineers, United States Army, at the Atlantic City convention of the American Institute of Electrical Engineers, June 27.

ENGINEER QUALIFICATIONS

What preparation is required for the fulfillment of these varied duties? For the actual technical work of construction or installation the civil training of the engineer should prove sufficient where the plans which embody the military features have been prepared or when the military technique has been learned and assimilated. A fundamental of this military technique is that the time element is to be considered rather than money cost and that the work must be done with whatever materials are available.

WHAT OUR ENGINEERS ARE DOING

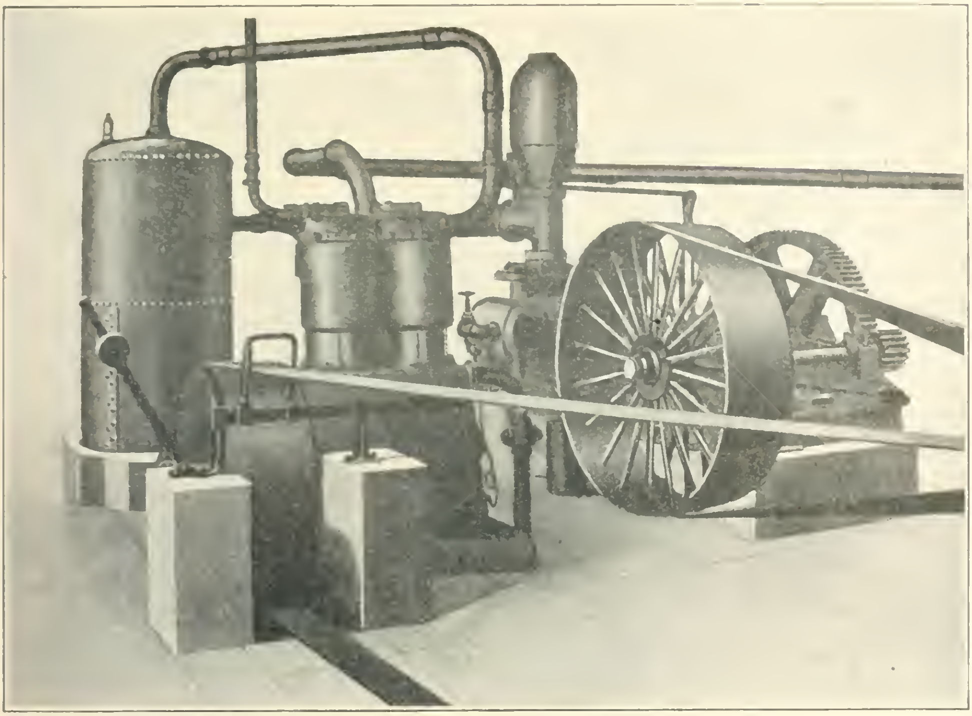
What have the engineers done? War was declared April 4, 1917. By the middle of July nine regiments of railroad engineers had been raised and organized and two had actually started for France. In each regiment were two officers of the Corps of Engineers of the regular army, the colonel and the regimental adjutant. The remaining officers were all from the Engineer Reserve Corps, some receiving their commissions only when on the point of sailing. Of course, few of the officers had had any previous military training and the tasks of organization were most difficult. Since then there have been organized five corps regiments, consisting of sapper, searchlight and sound-ranging troops; forty-three regiments and trains; two mounted battalions and trains; five pontoon trains; four inland-waterway companies; forty railway regiments and battalions, including all classes of standard gage and light railway troops necessary for the construction, operation and maintenance of railways; one railway transportation corps; one highway regiment; one gas and flame regiment; one gas training service: five forestry and auxiliary forestry regiments; one surveying and printing battalion; one military mapping service; two supply and shop regiments; one water-supply regiment; one quarry regiment; one mining regiment; one electrical and mechanical regiment; two crane-operating companies: one camouflage battalion; eighteen truck and auto companies, and forty-four depot detachments. The greater part of these organizations are now overseas. Some are serving with the British army, some with the French, but the majority are with our own troops, in service both at the front and in the rear.

AIR LIFT FOR HANDLING TAILINGS

BY H. A. CAMPBELL

Tailings from the mill of one of the largest copper companies in the Southwest are brought to a consistency of four or five parts of liquid to one of solid and allowed to flow by gravity through launders for about a mile where they then have to be lifted from 15 to 30 ft. and carried over a dam into a settling pond or dump. About 7,000 gal. per min. of this mixture is handled, and three 10-in. centrifugal sand pumps, direct-connected to 150-h.p. motors, were previously used. This method was found to be very expensive, as the tailings were sharp and cut out the casings and impellers of the pumps very rapidly, the average life of a pump not exceeding four days of continuous operation. Large motors were necessary, as the efficiency of the pumps dropped rapidly to a low point as wear occurred.

To obviate these difficulties, an air-lift system was installed and has proved a solution of the problem. At various points in the lower launder, openings were made discharging each into a 20-in. wood-stave pipe, which was set in a pit a sufficient depth to give proper submergence and closed at the lower end. Inside of this a 10-in. discharge pipe, fitted with a footpiece, is placed, through which air is introduced at the bottom and which discharges directly into the upper launder. This pipe has no bends and no obstructions inside, so very little wear can occur and renewal will be practically unnecessary. Three of these installations are able to handle the maximum tonnage. A separate compressor, driven by a 40-h.p. motor, is used for each air lift, although all three could easily be handled from a central plant if local conditions made it desirable. Compressors and motors are housed and require little attention. Operating costs and repairs have been cut to a small fraction of what they were with sand pumps, and the inconvenience of frequent shut-downs is eliminated.—*Eng. and Min. Journal.*



AIR COMPRESSOR AND PUMPS AT CURRAGH CAMP

AN AIR LIFT INSTALLATION AT AN IRISH CAMP*

An air lift pumping plant, combined with a set of two-throw surface force pumps, was recently supplied by Messrs. H. Brown and Co., of Princes-street, Bristol, for the Old Waterworks at Curragh Camp, County Kildare. Additional water being required, it was decided some little time ago to put down a bore-hole to a depth of 250 ft. from the surface. The particulars of the boring are as follows:—The first 25 ft. was sunk through gravel and fine sand, the excavation being eventually bricked with 9 in. brickwork, 3 ft. 9 in. square. From the bottom of this well the boring was first of all taken down to 75 ft. and lined with 15 in. inside diameter lap-welded mild steel screw-socketed tubes. Below this 15 in. tubing, 90 ft. of 12 in. internal diameter screw-socketed steel tubes were inserted, this lining being perforated with 1,400 ⅜-in. holes. A further 80 ft. of 10 in. internal diameter flush jointed well lining tubes were fixed below the 12 in. tubes, these 10-in. tubes being also drilled and having altogether 25,325 ⅜-in. holes in them. The whole of the perforations on both the 12-in. and 10-in. tubes are covered on the inside of the tubes by fine copper gauze, so as to form a sand screen to exclude the fine running sand with which the water is impregnated. Each series of tubes was fitted with a hardened steel cutting shoe.

The rest level of the water on the completion of the boring stood at 40 ft. from the surface. A pumping test of the yield of the well was made, the trial extending over a period of fourteen days' and nights' continuous pumping. It was carried out by means of temporary pumping machinery consisting of a direct-acting steam head of the single-cylinder type, the engine cylinder being 13½-in. bore by 36-in. stroke. The pump was placed at a depth of 85 ft. below surface level, and consisted of the usual type of bore-hole pump, 12-in. diameter by 3 ft. stroke, the valves being extractable from the surface and the bucket being worked by means of timber pump-rods. The rising main consisted of 13½-in. internal diameter steel tubes with screwed sockets. The dis-

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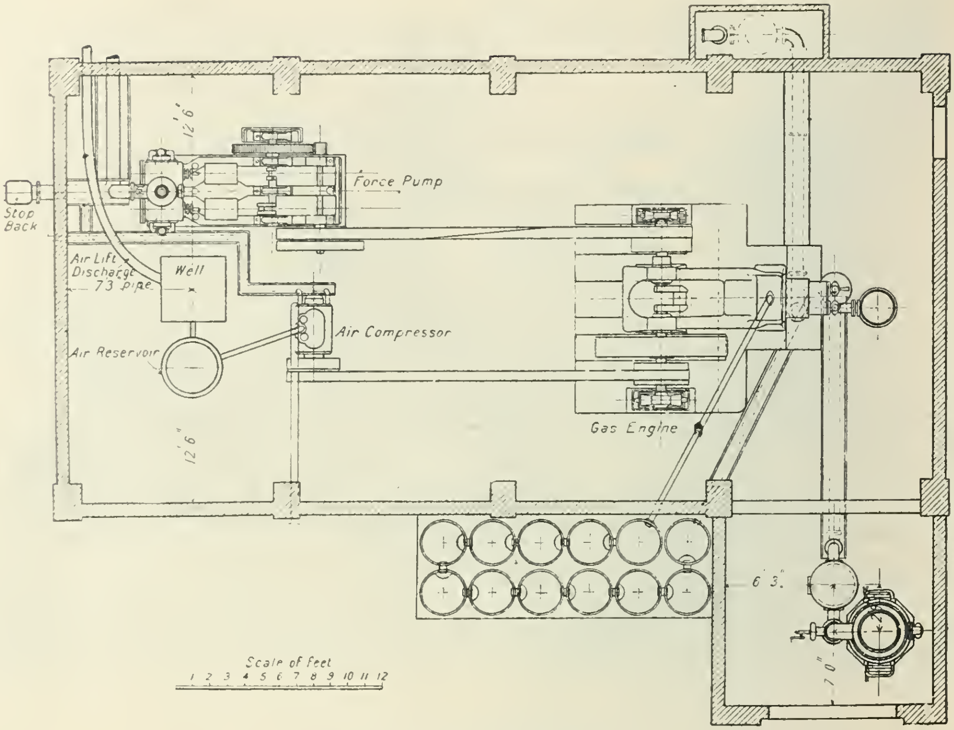
*The Engineer, London.



PLAN OF PUMPING PLANT

charge from the pump was led into a tumbling bay, consisting of a box provided with baffling plates. The water escaped over a weir 12 in. wide, a constant stream 4⅝ in. deep being maintained practically throughout the test. In other words, the bore was found to be capable of yielding up to about 20,000 gallons per hour.

For the permanent machinery it was decided—owing to the expectation of a certain amount of sand being retained in the water—to utilize the air lift system of pumping for raising the water from the boring to the surface where it is discharged. It was at first intended to use four settling tanks formed of cement concrete, each tank being 25 ft. long by 11 ft. wide, and each provided with two penstocks actuated from the top of the tank by means of hand wheels for charging and discharging. In these tanks it was intended that the water should have time to free itself by settlement of any sand before being passed on to the force pumps. Eventually, however, it was found that so little sand was raised that the idea of the four tanks was abandoned, and only one large tank was constructed to receive the discharge of the air lift pump. The water is raised from that tank by horizontal duplex plunger pumps through 726 yards of 8 in. main and against a total head of 170 ft. into a water tower.

The air compressor and pumps are driven by a National gas engine, which gives 96 brake horse-power when running on suction gas from anthracite coal. The air compressor, which was built by Broom and Wade, Limited, of High Wycombe, is of that firm's usual vertical type, all the working parts being enclosed. The cylinders, which measure 10 in. by 12 in., are designed to deliver 200 cubic feet of free air per minute, at a constant pressure of 60 lb. to the square inch when the compressor is running at 200 revolutions per minute. The machine is fitted with an automatic air governor, the air being accumulated in a receiver constructed of steel plates and measuring 6 ft. by 3 ft. The compressed air is conducted to a depth of 245 ft. below the surface by means of 3 in. internal diameter steel tubes, and is discharged through a copper nozzle perforated with ⅜ in. holes, the air pipes being run inside an 8 in. eduction main.

The surface pumps are of the duplex double-acting horizontal type, the plungers being 10¼ in. diameter by 15 in. stroke. They have a capacity of 20,000 gallons per hour, at a speed of 20 revolutions per minute.

CONTROL OF COMBUSTIBLE AND AIR IN BURNING POWDERED COAL

BY W. G. WILCOX*

Having considered the essentials of combustion, we can estimate the value of powdered coal as a fuel. In the same way we can ascertain also the conditions demanded for success in the combustion of pulverized fuel.

The simplest view of the combustion of coal is to regard it as a reaction between fuel and oxygen. It is a heterogeneous system; consequently the velocity of the reaction and its completeness will depend upon the surface exposed by the solid, the pressure of the reacting gas, and the intimacy of the mixture. By grinding an inch cube of coal so fine that 85% will pass a 200-mesh screen, we have increased the surface exposure from six square inches to approximately 1,800 sq. in. Thus we have increased the velocity of combustion 300-fold. By doing so, we have changed the characteristics of the fuel. We now have a fuel relatively 300 times more active than the inch cube of coal, a new type of fuel that has in it inherent possibilities not to be found in lump or slack fuel. By increasing the surface exposure 300-fold, we have speeded combustion proportionately. This carries with it a further effect. The increase in rapidity of combustion also increases the rapidity of heat evolution, and consequently quickly raises the temperature of the rest of the material. This rise of temperature, which is much more rapid than in the normal combustion of coal, will double the velocity of combustion for each rise of 10°C. The increased rapidity due to greater surface exposure and that due to temperature rise are superimposed so that a pulverized fuel affords a combustion that is hundreds of times faster than when burning lump-coal.

Having a finely-divided fuel it is possible to form a mixture of fuel and air so intimate that each small particle of coal is surrounded by the proper amount of air. In this condition, by maintaining the proper velocity of the air-current, the fuel can be carried into the furnace in suspension and there burned completely, efficiently, and rapidly.

It is, of course, a simple matter to mechanically control the amount of powdered coal delivered to the furnace in a given time. It is also possible to control the amount of air delivered with the coal. If, then, we deliver to the furnace an intimate mixture of air and powdered coal, and control the amount of coal-dust and air delivered, we have the prime essentials. The degree to which they are attained depends entirely upon how carefully we study the characteristics of the fuel before and during combustion.

The amount of coal-dust delivered can be controlled simply and positively by using a screw-feeder operated at variable speed. It is also a simple matter to control the volume of air admitted with the fuel; but the highest efficiency possible with this type of fuel will not be obtained unless we work out a correct way in which to mix a finely divided solid with the air.

A study of the methods for making such a mixture immediately shows that the methods commonly used in making a uniform mixture of two miscible liquids or a uniform solution of a solid in a liquid, or the methods used in mixing finely-ground solids are not only useless in this case, but will actually separate the coal-dust from the air. Ordinary mixing is done by agitation; this agitation is usually accomplished by baffling, stirring, shaking, or similar devices. When, however, such methods are applied to a mixture of gas and finely divided solid, the solid tends to separate by reason of its higher specific gravity. This, in fact, is the principle of the well-known cyclone dust-collector. Any mixing device that produces such agitation of the dust and air as to give a centrifugal effect will tend to separate, not mix, the air and the dust.

The importance of mixing the coal-dust and air intimately cannot be exaggerated. The rapidity of combustion is a direct measure of the intimacy of the mixture. This is well illustrated by comparing the ordinary gas-flame with the flame obtained in the Bone combustion system, which consists in forcing the proper proportion of air and gas through a diaphragm having numerous interstices. When this mixture is ignited on the other side of the diaphragm, it produces a film of flame.

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*From a paper before the Western New York section of the American Chemical Society.

The poorer the mixing, the longer the flame. The flame simply outlines the area in which combustion is taking place and the length of the flame is a measure of the time element necessary to accomplish combustion. This time element—other conditions being equal—is absolutely a function of the intimacy of mixture, as was noted by Breckenridge ten years ago, when in Bulletin No. 325 of the U. S. Geological Survey, he stated:

"The conclusion is reached that the velocity of combustion decreases enormously from the surface of the fire to the rear of the combustion-chamber, where it is relatively very small, the practical application is that little is to be gained by adding further length of smooth combustion-chamber, which would be commercially as poor an investment of capital, as to add to the length of a Corliss engine-cylinder and stroke; we must resort to thorough mixing."

Just as in the past there has been a remarkable failure to realize the necessity for intimately mixing air and coal-dust, so there has been insufficient consideration of the characteristics of this fuel when burning. Powdered coal has the characteristics of a rich fuel of somewhat higher kindling temperature than producer-gas, natural gas, or fuel-oil. To illustrate the fact that it is a rich fuel, we can compare the available B.t.u. in a cubic foot of a correctly proportioned mixture of powdered coal and air and the available B.t.u. in a cubic foot of correctly proportioned mixture of pure methane and air. Take a Pittsburgh coal (heating value 14,157 B.t.u) of the following analysis:

	%
Volatile	35.4
Fixed carbon	58.5
Ash	6.1

We find that a cubic foot of a correctly proportioned mixture of coal-dust and air has available 107 B.t.u., while a mixture of pure methane and the proper amount of air has available per cubic foot, 62.3 B.t.u.

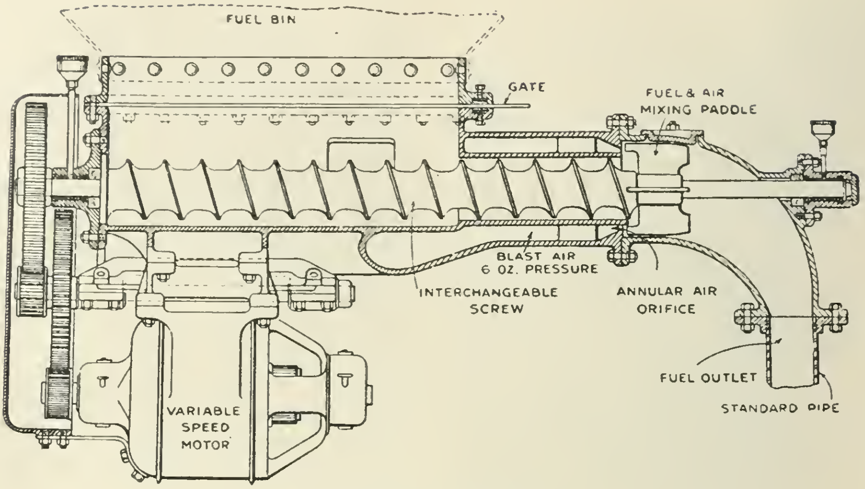
The rapidity of combustion and the completeness of combustion of a mixture of coal-dust and air depend upon a number of factors: for example, they are dependent upon the velocity and pressure at which it is passed into the combustion-chamber. If the velocity of the incoming stream of powdered coal and air is above the velocity of flame propagation, combustion will not take place until the mixture has slowed down to a point that it does not exceed the velocity of flame propagation. When a powdered coal is fired at high pressure and high velocity, combustion frequently does not begin until a point four to six feet from the mouth of the burner. A similar example is found in the plumber's blow-torch when too much air is used, or in the Bunsen burner when the gas-pressure is too high. High-pressure firing not only slows down combustion, thus increasing the size of the chamber necessary, but has a destructive action on the furnace. It has been well established that high velocities in the combustion-chamber or a blow-torch effect due to firing at high pressure (whether oil or gas be used as a fuel) are always destructive of the brickwork. This action is increased in high-pressure firing of powdered coal, since, in addition to the erosional effect of gases at high temperature traveling at high velocity, there is a fluxing action by the melted ash. Furthermore, the slagged ash will be carried along mechanically, leading to further furnace troubles. In one case this resulted in a deposit of slag on the mud-drum of a vertical waste-heat boiler at the end of a long reverberatory furnace. Slowing the velocity not only hastens combustion, but makes it possible to eliminate much of the slag. When the velocity is low the coalesced particles of slagged ash are either larger than will be carried by the velocity of the gas or this condition is so nearly approached that a slight change in direction of the flame will result in dropping out the slag. Thus, in addition to being correct combustion and necessary in order to avoid excessive furnace-maintenance costs, low-velocity combustion, by a slight change in flame direction, permits the dropping out of a large quantity of the slagged ash in the early part of combustion, where it can be removed and will not interfere seriously with efficient metallurgical operations.

The velocity of combustion is not only dependent upon the fineness of the particles of coal, the intimacy of the mixture, and the velocity of the stream of combustible and air, but is affected by the temperature of the combustion-chamber. The kindling temperature of a mixture of powdered coal and air is higher than that of either oil or gas; consequently for successful and complete combustion, it is necessary that the combustion-chamber be maintained above a certain minimum temperature and that the combustion be practically completed before the products of combustion pass over the heat-absorbing surface. Just as you can extinguish a gas flame by passing over it a piece of wire-gauze, so the effect of a chilling surface will be even more marked with this combustible material than with burning gas, since the particle of coal is infinitely larger than a molecule of gas and the kindling temperature is also higher. This has a direct application to the successful firing of locomotive boilers, water-tube boilers, and return-tubular boilers. If the combustion of powdered coal be not sufficiently developed before the flame enters the tubes of the locomotive boiler, combustion will be checked and coked coal settle out in the tubes. If, on the other hand, combustion be sufficiently developed before the flame is brought in contract with the heat-absorbing surface, complete combustion and high efficiency are obtained.

A study of the flame developed at a low pressure by an intimate mixture of coal-dust and air shows that combustion is extremely rapid. In a copper-reverberatory furnace at Florence, Colorado, where this type of combustion is used, coal burned at the rate of approximately one ton an hour develops a flame that vanishes within six feet of the burner, combustion being complete at that point. Let us translate this into terms of natural gas, in which case the fuel consumption would be approximately 26,000 cu. ft. per hour or 433 cu. ft. per minute. You can picture to yourself this quantity of gas being burned at low pressure and developing a flame only six feet long. Samples of gas taken in the flame show a content of CO_2 as high as 16% only five feet from the mouth of the burner. This will give an example of the rapidity with which combustion can be obtained and the possibilities of shortening the flame. With proper equipment it is equally practicable to lengthen the flame until it will spindle out a distance as great as 100 or 120 ft. However, with an intimate mixture under control, this must be done by supplying insufficient air. Under such conditions combustion is incomplete and the flame spindles out because combustion continues to develop throughout the length of the furnace as air-leakage supplies additional oxygen. This is proof of the statement that the length of flame is an actual measure of efficiency of mixing and the adjustment of the fuel-air ratio.

Thus, it is seen that we have changed entirely the characteristics of coal as commonly known. Powdered coal is a fuel of extreme flexibility, in that the amount burned can be varied within wide limits. It is a fuel that develops a flame whose length can be adjusted. The character of the flame can be altered to suit the metallurgical operation. In short, the basic fuel, coal, has acquired the characteristics of oil or gas, but with better and closer control. Furthermore, the possibilities of this fuel are not only capable of realization, but are actually being utilized in commercial practice to-day. To the flame characteristics of a rich fuel, developing a flame like oil or gas, is added a degree of control not yet obtainable in burning either oil or gas. This statement is made advisedly. The possibilities of such combustion for the improvement of processes, for fuel economy, for increasing output, through its ease of control and elimination of heavy labor, are realized by few. Owing to the attitude of labor and the scarcity of skilled operatives, it is far more difficult than ever before to secure high efficiency and good operation in hand-firing, stoker-firing, or in producers, in short, whenever such efficiency depends upon constant watchfulness and hot, heavy, disagreeable work. For these conditions powdered coal substitutes an ease of control such that the equipment can be handled by an old man or a boy, while it is so simple that a man of ordinary intelligence can soon be taught all that is necessary for good efficiency in operation. The possibilities of such control in the place of present-day combustion methods, which permit high efficiency only by the most strenuous effort, through substituting for these a type of combustion whereby high efficiency is easily obtained, are certainly of great importance to us at the present time.

Sulphur in Germany is being obtained at the present time almost exclusively by the reduction of gypsum. It is reported that deposits of anhydrite are similarly being utilized.



THE LOPULCO APPARATUS

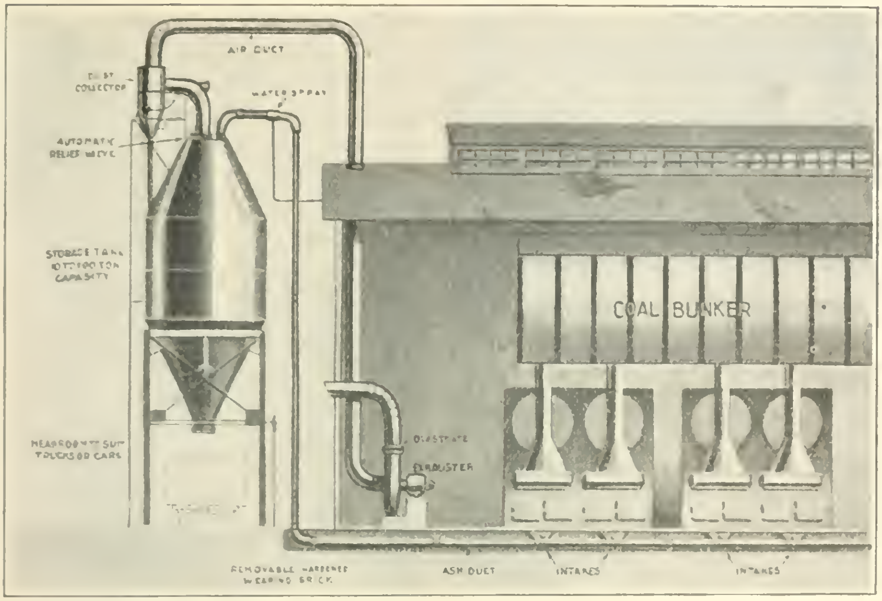
MIXER AND FEEDER FOR POWDERED COAL

The cut above shows the essential features of the "Lopulco" powdered fuel mixing and feeding apparatus of the Locomotive Pulverized Fuel Company, 30 Church Street, New York. It has been carefully developed and thoroughly tried out and has been found to be dependable under a wide range of conditions and with a great variety of conditions. It is of course applicable to stationary service as well as to locomotives.

The mechanism comprises a feed screw which serves to convey the powdered coal or lignite from the fuel bin to the mixer, where it is discharged into an air blast surrounding and concentric with the delivery end of the screw. The feed screw is driven through a train of reduction gears by means of a variable speed motor which makes feasible the modification of the rate of feeding to suit widely fluctuating power or heat requirements. As an example, the 5-inch feeder is capable of delivering fuel at a minimum rate of 850 pounds per hour and at a maximum rate of 3,400 pounds per hour, with 12 intermediate steps as may be required.

Attention is specially called to the applicability of this system for the relief of the New England coal situation. There are graphitic coal beds underlying portions of Rhode Island and Massachusetts north of Buzzards Bay which has been thought of little value as fuel, and the material has hitherto been mined chiefly for the recovery of the graphite of which it contains a large percentage. As a fuel it is high in both ash and moisture, and being more highly metamorphosed than is the anthracite in the Pennsylvania fields, it is entirely unsuited for use as fuel under ordinary conditions. In the pulverized form, however, it was found to burn readily as a substitute for Pennsylvania anthracite, the one observable difference being in the greater accumulation of ash which was to be expected from the nature of the fuel itself.

The availability of this fuel to industrial New England is a matter of all the greater importance in view of the difficulty which our coal producing and transporting facilities are having in meeting the reqirements of the different sections of the country. In view of this circumstance there is offered the possibility of a more dependable fuel supply for the New England mill district than that district was able to enjoy last winter. While, at the same time, the one million or more tons of fuel that went into that district from the Virginias and elsewhere would be conserved for other regions not having a native supply and the railroads would be relieved of the necessity of hauling that volume of coal through a territory where transportation lines and terminals are already seriously overcrowded.



GENERAL ARRANGEMENT OF SUCTION CONVEYOR FOR ASHES

SUCTION CONVEYORS FOR ASHES

BY REGINALD TRANTSCHOLD*

Particularly suitable for plants of considerable size is a system for handling ashes which utilizes the rush of air through a conveyor duct, or pipe, to an elevated storage tank, where a certain degree of vacuum is maintained by means of a high speed exhaust fan. This represents the most highly developed mechanical method of accomplishing the ash handling task. The conveyor proper consists of a heavy cast-iron, or steel, pipe running before the various boilers, under the boiler room floor, and in which small intakes are located for the receipt of the ashes from each boiler. This conveyor pipe continues out to an outdoor elevated storage tank into which the ashes are sucked. The various intakes leading to the conveyor duct are kept tightly closed, excepting when the conveyor is being actually charged with ashes.

When the conveyor is to be operated, the boiler man simply rakes the ashes to the intake, then he removes the cover and the rush of air through the opening toward the partly exhausted storage tank takes the ashes with it. The ashes are transported virtually in suspension, so there is relatively little abrasion caused by the swiftly moving ashes on any straight runs of the conveyor duct.

Whenever the direction of the conveyor duct changes, however, the flying ashes are impinged obliquely against the far side of the pipe, or connection, i. e., the elbow, with considerable force and the result is a severe scouring action which will, in a short time, wear through any elbow of ordinary construction. This abrasive wear is the chief cause of direct deterioration of suction conveyors.

To reduce it the elbows are made with removable backs of hard manganese steel, carborundum, reinforced glass, or other material possessing high resisting properties. These elbows are placed wherever the general path of the conveyor duct makes a change in direction, and so pronounced is the abrasive action of the fine particles of ashes that the hardest elbow is brought to a high state of polish in a short period of service. The polished surface then tends to reduce the rate of deterioration and, at the same time, to prevent loss of carrying capacity by any slowing down of the rushing air.

The exhaust fan creating the partial vacuum in the storage tank, removes the air from the top part of the tank. Between the exhaust connection and the discharge inlet of the con-

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*Industrial Management.

RAKING ASHES INTO CONVEYOR

veyor duct a water spray plays on the ashes as they enter the storage tank, quenching them and precipitating the fine particles which would otherwise be sucked into the intake of the fan. As the operation of the system depends upon the success with which the air is exhausted from the tank, it is necessary that this exhaust tank be made air tight, with admission of air only possible through the conveyor duct, via the opened intakes in front of the boilers.

The ashes being carried in virtual suspension, the carrying capacity of a suction conveyor is quite limited, necessitating more continuous operation than equipment which carries the ashes in buckets or cars. A 4-inch suction conveyor, i. e., one with a conveyor duct of 4-inch pipe, has a carrying capacity but little over 2½ tons per hour, while a 12-inch conveyor, about the largest size employed, has an hourly capacity of somewhat less than 25 tons an hour. The capacity of conveyors between these limiting sizes varies directly as the square of the conveyor duct diameter.

The diameter of the conveyor duct, besides governing the carrying capacity of the system, governs also the size and power of the exhaust fan and, as the exhauster is the chief item of expense, the cost of an installation for one or two boilers is very nearly as great as the cost for one caring for a much larger boiler plant. Also, the consumption of power is nearly the same in a short conveyor system as in a long one of equal capacity. These peculiarities tend to limit the use of such methods of handling ashes to the larger plants where the high initial cost of installation and the cost of maintenance are discounted by continuity of operation made possible by the large quantity of ashes handled.

Provided no large clinkers are formed that have to be broken up before feeding to the conveyor duct, there is no question but that the suction system of handling ashes is the most convenient so far evolved, and is to be highly recommended for the plant that can afford the high initial cost of installation. When nothing unforeseen occurs in the boiler room and the suction conveyor is in good operating condition, the system is about as nearly "fool proof" as any system for mechanical handling of ashes can well be, for it is impossible for the careless fireman to force unbroken clinkers, or any other material which might choke up the conveyor duct, through such small intakes as are provided for the ordinary feed of fine ashes. There is one note of warning, however, that should be sounded, for, this point neglected, the highly efficient system might turn out as deadly as a German bomb.

Should it be necessary to pull an active fire in an emergency, a serious accident might occur were incandescent particles of coal passed into the conveyor duct. These glowing pieces lose little of their heat during their brief journey through the conveyor and reach the water spray at close to grate temperature. The still incandescent fuel may give off explosive coal gases and even disintegrate the water vapor, as in the case of a suction gas producer. These explosive gases collect in the pockets formed in the top part of the confined storage tank—despite the suction of the exhaust fan—and have been exploded with disastrous results by a piece of incandescent fuel sucked into the tank. The danger of such an accident is slight, it is true, but the seriousness of the danger makes its mention advisable—particularly as all risk can easily be avoided by the exercise of a little care. A timely word of warning: incandescent fuel should never be fed to the conveyor.

STEAM JET SUCTION CONVEYOR

Another system, one also employing the rush of air through a conveyor pipe, or duct, to carry the ashes in suspension, and one which is more suitable for a plant of small boiler capacity than the more expensive system just described, is a system in which a jet of live steam is directed into the conveyor duct at some point beyond the last intake for ashes —usually at about the point where the conveyor duct rises to elevate the ashes. The steam jet, discharging in the direction of travel, creates a vacuum of 16 or 25 inches of water and induces a rapid flow of air through the conveyor duct, from any open charging intake. Such an installation will elevate ashes as much as a hundred feet, convey them over horizontal stretches of several hundred feet and up a reasonably tall section of vertical conveyor duct to the elevated storage tank.

The diameter of the conveyor duct is usually made 6 or 8 inches, and the capacity of the conveyors is usually about the same as that of the more elaborate suction systems, namely, about 5¾ tons per hour for the 6-inch conveyor and 10¼ tons for the 8-inch. To handle such a quantity of ashes, about 7 or 8 per cent. of the steam generated by the boilers cared for is required, but only while the conveyor is in actual operation. In one plant where careful measurement of steam consumption was made, 1,850 pounds of steam, under 110 pounds gage pressure, were required to handle 7 tons of ashes from four 400 horsepower boilers.

In this steam jet vacuum system, the ashes are usually allowed to accumulate in hoppers below the grates and only fed to the conveyor duct during periods when steam can safely be withdrawn from the boilers for the service of creating the required suction in the conveyor duct. The ashes are, therefore, usually comparatively cool when they pass through the conveyor and contact with the steam jet is sufficient to settle the fine particles of dust and deliver the ashes to the storage tank in a suitably quenched condition.

The wear at conveyor duct elbows, etc., is nearly as marked as in the vacuum system employing an exhaust fan, and deterioration may, in this second system, be somewhat aggravated on any horizontal or vertical stretch after the ashes have come in contact with the expanding steam by the formation of acid fumes. However, the storage tank in this system may be ventilated and so allow for the escape of fumes and any explosive gases which may be generated and carried into the tank.

AIR HELPS IN OIL WELL

The Carter Oil Company some time ago struck oil in the Towanda pool, Butler County, Kansas. It was reached by the drill at 2,396 feet and as far as could be told it was the same sort of formation and just as thick as the sand found in other wells in the district. The drill was sent 65 feet into the sand and the well started in as a steady producer at 3,000 bbls. It kept this up for 10 days and then suddenly the flow went up to big figures and it kept this rate for nearly two weeks. Then the flow began to dwindle and in four days ceased to flow any oil. The well was swabbed out and it began flowing again and in a few days it began to dwindle in production. Then the Carter officials decided to try the use of air. An air line was put down inside the casing. The line had numerous small perforations in the part standing in the sand. A compressor was hooked up and began pumping air down into the hole. In a single day the oil began flowing at a higher rate than even before and now is producing the fluid bountifully and promises to continue this production.

GASOLINE FROM CASING-HEAD GAS

Casing-head gasoline is made by two different processes, the compression process and the absorption process. In the compression process the wet gas is compressed by large machines to a pressure between 200 and 300 pounds to the square inch. The compressed product is then cooled and the "wet" parts of the gas condensed. The high-gravity product is then mixed with low-gravity distillates and kerosene, which can not be utilized by themselves in automobile engines. However, the addition of the light-gravity gasoline gives the resulting mixture a volatility sufficient to permit ready combustion in automobile motors.

The absorption process of making gasoline may be used for casing-head gas or for gas that does not occur with the oil. This process is based upon the fact that when the wet parts of the gas are forced through certain kinds of oil used for absorption, the oil absorbs the light particles of gasoline carried by the gas. These are later recovered from the oil by heating it, the gasoline being driven off and the high-gravity product being condensed. The product of the absorbers is blended with a heavier distillate as is the product from compressing casing-head gas.—*Yearbook of the U. S. Bureau of Mines.*

EXPANSIVE FORCE OF QUICKLIME

Some interesting particulars regarding the expansive force exercised by quicklime under the action of moisture have been communicated to the *Ironmonger.* Quicklime, as is well known, develops, when wet, an enormous expansive force that acts slowly, and, consequently, has peculiar mechanical advantages. Efforts to utilize this force have been successfully employed recently to break up heavy brick masonry. Several piers, 12 ft. by 20 ft. on plan, and 12 ft. high, were situated between similar foundations on which were fixed machinery which could not be disturbed. The problem was to break up the masonry no longer required without damage to the rest of the plant. Blasting was inadmissible, and hand-cutting and breaking too slow and expensive. The work was accomplished by drilling 3 in. vertical holes 3 ft. deep and 3 ft. apart in both directions over the entire area of the piers, and filling them within 6 in. of the top with lumps of fresh slacked lime which was thoroughly wetted. The tops of the holes were then filled with brick drilling well tamped, and in about ten minutes cracks started in every direction, and the entire top of the foundation pier was broken into 3 ft. cubes.

"LAUNDRIES" FOR AIR BRAKE PUMPS

The cut upon the opposite page with the following descriptive matter is from a report presented at the recent annual convention of the American Air Brake Association telling of the means employed on the Minneapolis, S. Paul and Sault St. Marie R. R. for cleaning the air brake pumps or compressors without taking them down or in any way dismantling them.

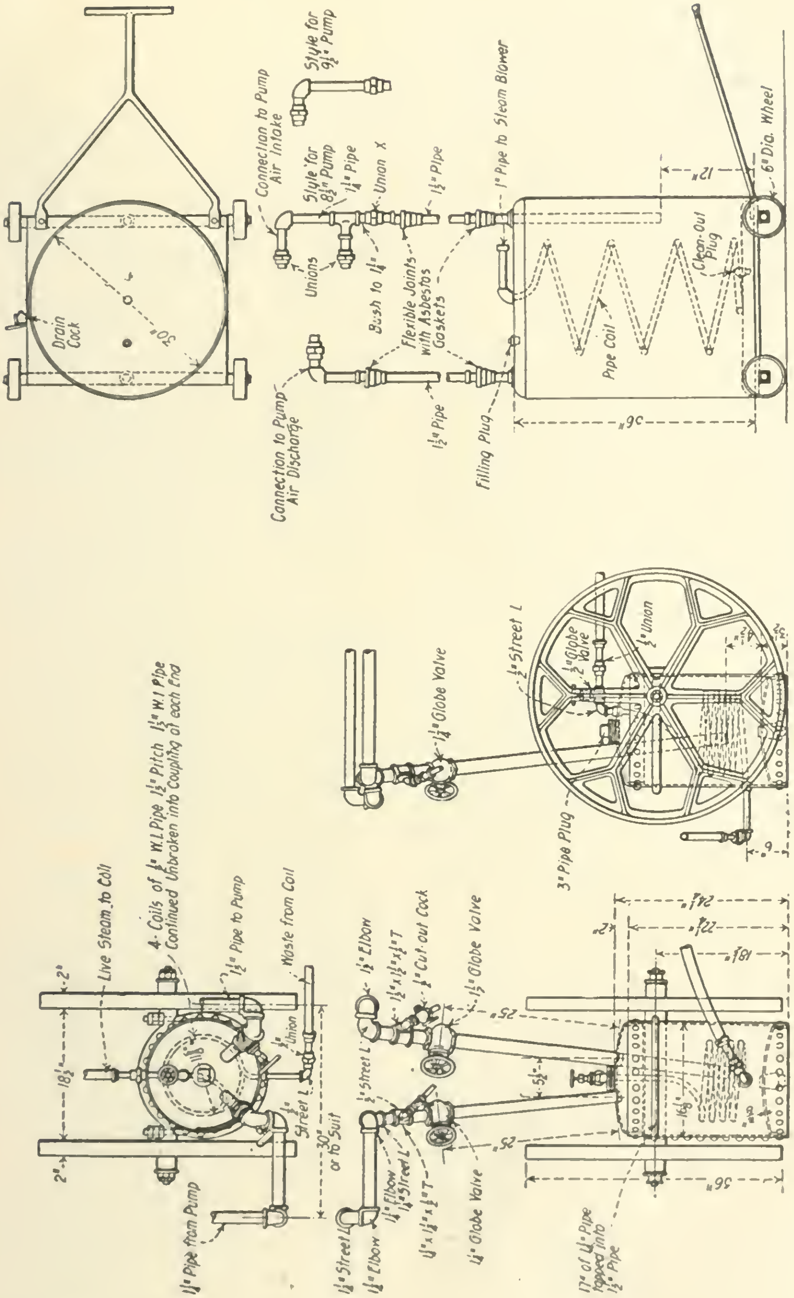
Dirt entering the cylinders of an air compressor destroys lubrication and increases the wear of packing rings and cylinder walls. The dirt and worn-off metal, coupled with heat of compression, form the hard gum so frequently met with; hence, excluding dirt will improve lubrication and reduce wear and gumming. Clogged and gummed passages and ring grooves of the compressor are responsible for a portion of the trouble, such as reduced efficiency, pounding, running lame, slow speed, etc.

A very effective and economical way to remove this deposit is by means of the compressor "laundry," which should be used every three months or so, depending on the service and protection afforded the compressor against dirt. The illustration shows two types of air compressor "laundry" outfits, as developed by the Soo Line Ry. They consist in general of an enclosed tank mounted on wheels, for a lye solution, a steam pipe coil inside the tank and suitable pipe connections to join the tank to the suction and discharge openings of the compressor. The solution should consist of about one pound of concentrated lye to one gallon of water, and should be kept hot by steam circulating through the coil while the compressor is being cleaned.

To operate the outfit first see that the air cylinder piston rod packing is tight, then remove the air strainers and disconnect the discharge pipe at the compressor. Connect the supply and return pipes from the "laundry" to the compressor air cylinders, also a steam line to the steam coil. After the solution is at or near the boiling point, open the compressor throttle and permit the compressor to operate at slow speed with the solution circulating through the air cylinders and discharging back into the tank.

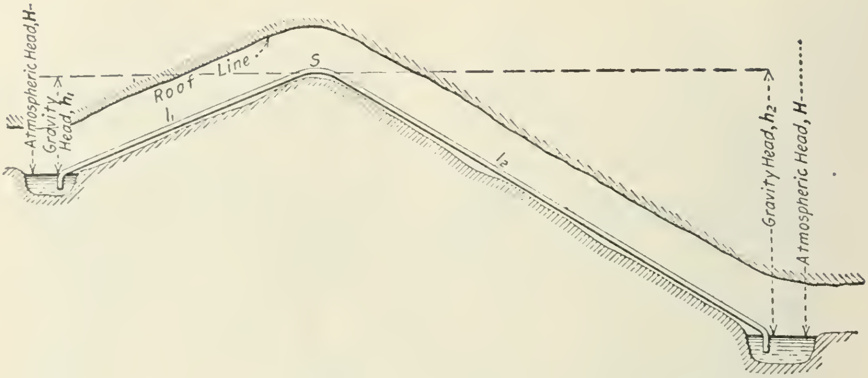
The length of time the compressor should thus operate depends on its condition, but usually from two and one-half to three hours give the best results. After the compressor has been thoroughly cleansed the tank connections should be removed. Clean water (hot water is preferable) should then be worked through the air cylinders for several minutes, discharging into the pit, to insure all of the solution being removed, after which the compressor should run idle until all the water is worked out of the cylinders. The air cylinders should then be well lubricated, the strainers re-applied and the discharge pipe connected. If soft packing is used the air ends may need to be repacked.

The method here outlined for removing the gummy deposits from air cylinders of a compressor is far superior and more economical than to cut it out with chisel and scraper. When the old method is used it comprehends much labor in the removal and replacement of lower cylinder heads and air pistons, and then the ports only can be cleaned. After the "laundry" outfit is connected to the compres-



TWO "LAUNDRIES" FOR AIR BRAKE PUMPS

sor it does not require an attendant during the two and one-half or three hour period mentioned, other than an occasional visit to observe that all is going well. A solution of about ten gallons mixed as herein mentioned will be sufficient to cleanse about five compressors, other than the possible exception of adding lye to maintain its strength.



MINE SIPHON PRACTICE

The following careful statement of the conditions necessary to be observed for the successful installation and operation of mine siphons has been prepared by *Coal Age* in reply to a question by a correspondent.

The essential requirements for the successful operation of a mine siphon are the following:

1. The pipe line must run full; that is to say, the size (diameter) of the pipe must be such that it will conduct the required flow of water, under a velocity determined by the effective head and the frictional resistance of the pipe. This is necessary in order that the water flowing through the pipe shall sweep away any air that might otherwise separate from the water and accumulate at the crown of the siphon.

2. In order that the siphon shall run full continuously, the diameter, length and effective head must bear a fixed relation, in both branches of the pipe. For example, the ratio of the fifth power of the diameter, in inches, to the length of the pipe, in feet, multiplied by the effective head, in feet, must be the same for both the intake and discharge ends of the siphon. The *effective head* at the intake is the atmospheric pressure minus the vertical lift from the level of the water in the supply basin to the crown of the siphon. The *effective head* in the discharge end is equal to the vertical height of the crown of the siphon above the point of discharge minus the atmospheric pressure.

3. There must be no leaky joints in the pipe, and all unnecessary obstructions, in the form of sharp bends in the pipe, valves, and other hindrances must be avoided as far as practicable. The mouth of the pipe must be kept sufficiently submerged beneath the surface of the water in the supply basin to permit no air to enter the pipe at that end.

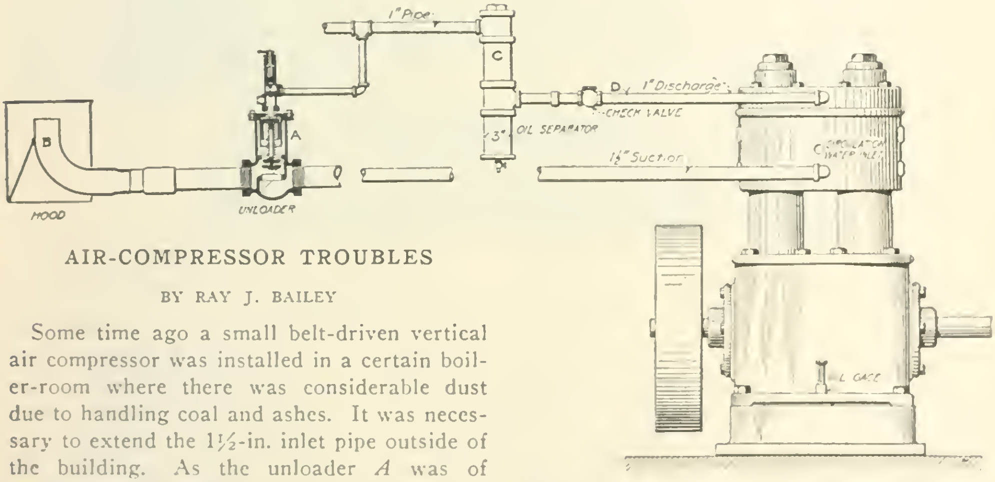
A siphon that fulfills these requirements will run continuously. In order to start the siphon, it is necessary to fill the two branches of the pipe through an opening at the crown, which must then be tightly closed by a good valve. During the filling of the pipe, both the intake and discharge ends must be tightly plugged or suitable gate valves must be provided at these points and closed until the pipe is full. Sometimes a small pump is used to fill the siphon instead of pouring the water into the pipe at the crown.

When a siphon line is not properly proportioned, as here explained, it will empty itself in a short time or the accumulation of air at the crown will prevent its operation. To avoid the first of these conditions it is common to use throttling valves to control the flow of the water at the discharge end, and to escape the second condition an air trap must be provided at the crown, through which the accumulated air can be withdrawn from time to time as necessary.

Referring to the accompanying figure and calling the atmospheric head, H, expressed in feet of water column, the gravity head, in feet, length of pipe, in feet, diameter, in inches, on the intake end, h_1, l_1, d_1; and, on the discharge end, h_2, l_2, d_2, respectively; the effective intake head is $H-h_1$, and the effective discharge head h_2-H. The relation of these elements, as stated in the foregoing rule is then expressed by the formulas

$$(H - h_1)\frac{d_1^5}{l_1} = (h_2 - H)\frac{d_2^5}{l_2}\text{; and } d_1 = d_2\sqrt[5]{\frac{(h_2 - H)l_1}{(H - h_1)l_2}}$$

These formulas are practical and should always be used to determine the sizes of pipe best adapted to different conditions regarding the length and vertical lift, or rise and fall, in each branch of the siphon. Also, it is well to remember that the atmospheric head *H* will depend on the depth of the mine and the system of ventilation employed. In practice, a good aneroid should be first compared with a standard mercurial barmometer on the surface, and then taken into the mine where the increase in the reading is noted. The increase, if any, is added to the reading of the barometer on the surface and the result multiplied by 13.6, the specific gravity of mercury, and divided by 12 to reduce inches to feet, will give the atmospheric head *H*, expressed in feet of water column.



AIR-COMPRESSOR TROUBLES

BY RAY J. BAILEY

Some time ago a small belt-driven vertical air compressor was installed in a certain boiler-room where there was considerable dust due to handling coal and ashes. It was necessary to extend the 1½-in. inlet pipe outside of the building. As the unloader *A* was of sensitive construction and as the least bit of dirt would make the pistons stick, causing poor regulation, considerable power was wasted because of the safety valve on the receiver releasing continually.

It was desired to connect the pipe as direct to the compressor and with as few fittings as possible, which located the end of the suction pipe between the eaves of three roofs. To keep it free from water and other obstructions, a hood was made, as shown at *B*, from 6-in. galvanized sheet-metal pipe with a 2-in. sheet-metal pipe on the inside soldered to a 2-in. galvanized pipe nipple. These parts were all taken from used material found about the factory. This arrangement has worked satisfactorily for nearly a year, and it has never been necessary to clean out the unloader nor has there been any trouble from poor regulation.

For lubricating the cranks, crosshead pins and pistons, four or five gallons of a certain quality of engine oil was put in the crank case when the machine was first installed. After a few days the oil was found unsuitable for this class of work, because, being thin, it would work past the pistons—which are exposed at the crank end—to the oil reservoir and about one pint per ten-hour run would pass through the valves and discharge pipe, burning on the valve stems and springs and causing them to stick and hold away from their seats. A portion of the burned oil would work into the unloader and make trouble.

An oil separator *C* was made from pipe fittings and two 3-in. nipples, each 6 in. long. A special air-compressor oil was used, and no further trouble has been experienced; less than one ounce of oil gets into the separator in thirty days.

Considerable advantage was gained by using a check valve in the 1-in. discharge pipe *D* when it was necessary to shut the machine down to examine the valves or to do work on the machine under pressure. It also serves to take the strain off the discharge valves due to the hammering effect when closing.

Several swing checks were used, which lasted but a week or ten days before the disk and seat had to be faced off and fitted so they would not leak. A horizontal globe check valve was then used, with the disk guided by a stem above and another below the seat. After being in service about four weeks, an examination showed that the stem and guide under the disk had worn away, the disk and upper stem and guide being in fairly good condition.

A check valve of the dashpot type is recommended as the best for this service, in which the upper part of the valve disk is connected to a dashpot, which will prevent its slamming. —*Power.*

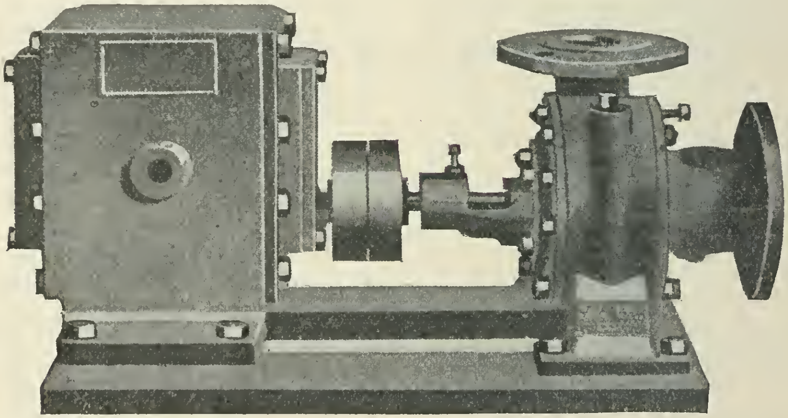
COMPRESSED AIR-DRIVEN CENTRIFUGAL PUMP

The portable compressed air turbine-driven centrifugal pump here shown is built by Hugh Wood and Company, Newcastle-on-Tyne. It has been designed for handling small quantities of water up to 90 gals. per minute up to heads of 80 ft., and comprises a single-stage centrifugal pump coupled direct to a compressed-air driven turbine, both mounted on a cast-iron bedplate, the over-all dimensions being 24 in. long by 12 in. wide by 12 in. high, and the weight about 2½ cwt.

The small weight and size enable the set to be readily moved, and the compressed air drive, which is safe and simple, makes it specially suitable for collieries, shipyards, etc.

The turbine is of very simple construction, having no delicate valves, etc., in its construction, which consists primarily of two rotors, with stepped teeth, mounted in ball bearings, to obviate wear and repairs. The only valve is that for the air inlet, which is connected to the ¾ in. hose pipe. The turbine works satisfactorily at any air pressure between 50 and 100 lb. per sq. in., and develops up to 5 h.p. The speed is automatically adjusted to that required for the head and quantity.

The pump is a single stage Sulzer centrifugal pump, and is connected to the turbine driving shaft by a flexible coupling of the rubber pin type.



Run at a speed of about 3,020 revolutions per minute, the pump will deliver 95 gals. at 74 ft. head (approximately 24 tons per hour), or 50 gals. against a head of 80 ft., power consumption being 3½ and 2.3 horse-power respectively. For lower speeds delivery and power are correspondingly smaller—e. g., 65 gals. at 21 ft. head (0.95 horse-power), or 50 gals. at 24 ft. head (0.85 horse-power). The maximum suction lift is 20 ft. for deliveries up to 50 gals., and 18 ft. for 65 to 95 gals. per minute. The suction and delivery nozzles are about 2½ in. inside diameter.

Comparative evaporation of coal, oil and gas, according to the United States Geological Survey, is as follows: Under favorable conditions 1 lb. of oil will evaporate from 14 to 16 lb. of water from and at 212 deg., 1 lb. of coal will evaporate from 7 to 10 lb., and 1 lb. of natural gas will evaporate from 18 to 20 pounds.

A DRIFT-BOLT DRIVER FOR WOODEN SHIPS

While shipbuilders are bending every effort to speed up each step of ship construction, the builders of the tools that play so important a part have not been idle. Their task is the development of new and better machines, so that a few seconds may be cut from the time required for each operation.

The latest contribution is an air hammer especially designed for drifting up bolts. This tool enables one workman to do in a short time that which would otherwise be a relatively slow task needing two men. There is also the consideration that the new hammer makes the work far less fatiguing.

The tool in question is styled Ingersoll-Rand No. CC-251 Drift Bolt Driver. Its distinguishing feature is a telescoping leg or air feed. This portion of the device consists of two sections of seamless steel tubing, one of which slides within the other and is provided with an air tight cup leather. Air when admitted extends the tool until it is against the bolt to be driven, where it is firmly held by air pressure while the bolt is being driven. A single three-way throttle controls both functions of the tool.

The hammer element is identical with that of the No. CC-25 Drift Bolt Driver. The new tool is very powerful and will drive bolts of 1½-inch diameter up to 10 feet long. It weighs 90 lbs., is 55 inches in length when air feed is closed and 77 inches when fully extended.

In its special field it is of distinct advantage and should be a welcome addition to the air tool equipment of the yards turning out wooden hulls.

HOW BIG A COMPRESSOR TO BUY

BY LEE A. KNIGHTS

In selecting an air compressor for the new mine, quarry or contract, the first consideration is naturally to determine what machines or tools and how many are to be operated by the air power.

Practically all handbooks on compressed air, and many manufacturers' catalogues, have for many years contained tables purporting to show the air consumption of a number of different drills of various sizes. It is obvious that a table cannot be prepared that will be correct for all conditions, as, for instance, if eight drills were working in two headings of a tunnel it is probable that all of them would be working at the same time and would, therefore, require eight times the amount of air that a single drill would. If, on the other hand, eight drills were scattered around over an excavation to be used for putting in "pop" holes, it is extremely unlikely that over five or six would ever be working at the same time, so a compressor supplying five or six times enough air for one drill would be ample to take care of the entire eight.

A little reflection will show that the only factors that need to be seriously considered in estimating the requirements to take care of a number of drills are the air consumption of each drill and the greatest number of drills that will be operated at one time. If the air receivers are of exceptionally large capacity, they may be counted on to assist materially in carrying the peak load, but under the majority of conditions the receiver capacity may be disregarded, as receivers are usually only large enough to equalize the fluctuations in pressure due to the pulsation of the compressor, and serve merely as equalizers and not as storage reservoirs.

In comparatively large installations, by which is meant those of twenty or more drills, the compressor capacity may be estimated from the probable average reciprocating time of the drill. For instance, if fifty drills are to be installed, and it is expected that each one will be actually running 75 per cent. of the time, the air required will be 75 per cent. of the amount of air one drill takes, multiplied by 50. This method of estimating should only be used for comparatively large installations. For instance, if two drills are to be installed, which will probably run 75 per cent. of the time, it is, of course, necessary to furnish compressor capacity enough for the two instead of one and one-half, since both would be working at the same time. This method of estimating should never be used unless the probable lost time of the drills is equal to at least one drill. That is, 75 per cent. of 2 equals 1½; 75 per cent. of 3 equals 2¼; 75 per cent. of 4 equals 3. Therefore, we could expect only three drills out of four to be working on the last mentioned installation, and could, therefore, plan on compressor capacity enough for three drills. We cannot, however, assume 2¼ out of 3, as it is evident that either two or three drills will be working and so it would be necessary to have enough air to run the entire three.

OTHER AIR USES

In addition to the actual requirements of the drills or other main installation of machinery, a liberal allowance should be made for use in other machines, such as pumps, motors and forges, and also for leakage. It is folly to attempt to discourage the legitimate use of compressed air, for this is a very economical and efficient method of transmitting power and accomplishing certain results, but great emphasis should be placed on the unnecessary waste of it, especially by leakage.

LOSSES FROM LEAKAGE

Very few people fully realize the losses due to leakage of compressed air. A hole one-sixteenth of an inch in diameter will cause a loss of about six cubic feet of free air per minute at 100 pounds pressure. A one-eighth-inch hole will allow a loss of over 25 cubic feet per minute, or enough to run a small tool. A quarter of an inch hole will allow over 100 cubic feet per minute to escape, or enough to run a modern rotating hand hammer drill or a stoper. It is seldom that the leakage from a quarter of an inch hole would go unnoticed, but a multitude of smaller leaks are frequently allowed, which reduce the total efficiency of the installation to an almost unbelievable extent.

It is only necessary to run the compressor through the noon hour, or at some other time when no machines are working, to see just how many revolutions the compressor has to make to take care of leakage alone, since at that time no effective work is being done. If it requires 50 revolutions of the compressor per minute to keep up the pressure with no machines running, it is evident that if the compressor is normally running at 200 revolutions per minute, only 150 of the revolutions are furnishing air for efficient use, and the other 50 are merely taking care of the leakage. Unfortunately this test is very likely to leave one with a rather unsatisfactory opinion of the plant, but it serves the useful purpose of impressing one with the necessity of making a liberal allowance for leakage in future installations, and, still more important, makes it easy to keep leakage at the minimum, by checking up this loss from time to time, as machines are added and pipe lines extended. The above considerations of course apply to compressor plants wherever and for whatever service installed.—*Granite, Marble and Bronze.*

GASOLINE FROM NATURAL GAS BY COMPRESSION

BY W. P. DYKEMA*

Plants treating natural gas for its gasoline content fall under one of three mechanical and physical subdivisions—compression, refrigeration, and absorption, or a combination of these methods. Each division varies widely in mechanical details of both equipment and operation. Gasoline recovery by compression and refrigeration will be discussed in the following pages. Recovery by absorption methods has been described in Bulletin 120.

THEORY OF PRECIPITATION—CONDENSATION BY COOLING

The theory of the precipitation of vapors from natural gas is in a way comparable to that of the precipitation of water vapor from the atmosphere. Water vapor is known to exist in the air at all times in varying proportions, but is invisible unless condensed by cooling. Cooling to a temperature below that at which the air is saturated with the water vapor it contains causes precipitation in the form of snow, hail, frost, rain, fog, or dew. This fact is also illustrated by beads of water collecting on the outside of a pitcher of ice water, and by the formation of frost on the refrigeration pipes of expansion units. The air coming in contact with the cold surface of the pitcher or pipes is cooled below its dew point and the moisture which it can no longer hold as vapor condenses as water or frost on the surface. By further cooling of the air more moisture would be condensed, and if cooling were carried far enough practically all of the water vapor could be precipitated without the aid of pressures higher than atmospheric.

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*From Bureau of Mines Bulletin 151.

CONDENSATION BY COMPRESSION

In plants compressing air it is found that air, after having been made more dense by increase of the pressure and decrease of the volume, deposits moisture at atmospheric temperature, and as the pressure is increased larger percentages of the contained water vapor are precipitated. Hence either high pressures or low temperatures increase the condensation of the water vapor.

In the exceedingly dry atmosphere of the Arizona and Nevada deserts, operating air compressors at a pressure of 100 pounds and cooling the compressed air only to atmospheric temperature always causes precipitation of water, and of lubricating oils from the cylinders, in the air receiver. That all of the moisture in the air is not deposited in the receiver is shown by the fact that in pumps driven by compressed air some moisture freezes in the cylinders and also forms frost in the exhaust outlet.

The condensable fractions in natural gas, like those in air, are not visible under ordinary conditions, but at times the sudden release into the atmosphere of gas from confinement under pressure will cause vapors of hydrocarbons to form a mist resembling fog or steam.

In the treatment of natural gas for gasoline recovery the result desired could be accomplished either by compression or refrigeration, but the complex mixture of gases and vapors complicates the problem. Without an exact knowledge of the various members and the proportion of each to the whole, an attempt to calculate the most suitable pressures and temperatures becomes little better than a guess, and the most practical solution is by tests and experiments. According to the law of partial pressures, if gas contains 10 per cent. of condensable vapor and is under a pressure of 200 pounds, the condensable 10 per cent. has acting upon it a partial pressure of 20 pounds, or 10 per cent. of the total pressure. As the proportion of different condensable vapors in the gas becomes smaller through their partial condensation, the partial pressure acting on them also becomes less. The percentage of gage pressure acting on any one of the gas or vapor constituents varies in proportion to the percentage of volume occupied by that constituent. If the constituent is condensable, condensation will lower its proportion to the volume of uncondensed gas to a point at which the partial pressure acting on it is too small to cause further condensation, leaving a portion of the vapor uncondensed throughout the entire treatment. As the acting pressure becomes lower, condensation tends to cease, but lowering the temperature will cause further condensation. Under constant gage pressures and decreasing temperatures, the largest percentage of the heavier hydrocarbons contained in the gas is recovered, and the losses are confined to the lighter members.

Although all of the condensable vapor and even the true gases can be liquefied by increasing the pressure or reducing the temperature sufficiently, the application of these processes in treating natural gas for gasoline is limited by the commercial considerations. Extremes of either pressure or temperature would yield condensates too volatile for commercial use, also the machinery and other equipment required would be expensive to install and difficult to operate and maintain.

To recover the valuable hydrocarbon fractions that are held as vapors in natural gas, only such pressures and temperatures are necessary as can be obtained by the use of machines and fittings of standard construction and capacities. As the power used to compress the gas heats it, developing power by expanding the compressed gas cools it. By using the cooled gas as a refrigerant, the temperature necessary, in conjunction with the pressure obtained, to extract the maximum of commercial condensate can be developed.

The temperature and the pressure that will yield the most profitable results are those that together will recover the largest possible amount of condensates of low vapor tensions and as much of the lighter parts as can be so blended or handled as to conform with legal standards of safety and make a good motor fuel.

ABSORPTION THEORY

The absorption process for recovering condensate from natural gas is based on an entirely different physical property, that of the solubility of vapors in liquids. In this process the gas is brought into intimate contact with a liquid which dissolves or absorbs the vapors; these vapors are later distilled from the absorbing medium and condensed.

USE OF COMBINATION COMPRESSION AND REFRIGERATION PROCESS

As shown above, the fundamental principles of the compression process are compression and cooling of the natural gas to pressures and temperatures at which certain hydrocarbons condense.

Plants of this character are erected to treat casing-head gas from oil sands or from sands closely associated with oil, the gas being brought to the surface either between the casing and tubing of an oil well or with the oil in the tubing. The quantity of gas from each well is usually comparatively small and in some installations as many as 500 or 600 wells are connected with one compression plant of not more than the average capacity.

The dry (treated) gas is, at most plants, used on the oil leases to drive the gas engines of the compression plant, and also for gas and steam engines in pumping and drilling wells. A few compression plants sell the treated gas for commercial use in cities or for manufacturing purposes. The cost of pipe lines and equipment necessary to deliver the small quantities of gas to market would, in general, be excessive. There is seldom much gas left after the quantity necessary for furnishing power has been used.

WHEAT HOLDS THE YEAST BUBBLES

When Mr. Hoover told the bakers of the country last winter that they must forthwith begin to make their bread with twenty-five per cent. substitution of other cereals than wheat the country at large thought very little of it. It created no flurry and there was much commendatory comment. The bakers would go ahead "per instructions," we'd get bread plenty good enough; and we'd send more wheat to Europe. Good!

But everyone forgot about *gluten*—everyone, that is, but the unfortunate bakers. Bread won't rise without enough of it. Wheat has it. Corn and most other grains have practically none of it. Rye has a little. When, therefore, Ira Hanks, of Hanksville, who runs his bakery by rule of thumb and bakes his bread in the good old way, tried to take out twenty-five per cent. of the wheat flour and substituted, say corn, the result was something that would have disturbed the digestion of a Harlem goat. It didn't rise. It was solid and soggy. Brother Hanks lost many a wrathful customer. People went home to roll their own. In short, none but the scientific bakers, with modern machinery, and the technical knowledge necessary to utilize all the gluten in that seventy-five per cent. wheat flour that remained, were able to make a go of it.

The reason, of course, was simple. Gluten is sticky. When the gas from the fermented yeast begins to generate in the dough of wheat flour, the abundant gluten holds it in; bubbles form, and the dough "rises." Try it with any cereal which lacks gluten, and it won't rise. The gas escapes.

A wheat base is therefore necessary for the making of palatable light bread. If the wheat flour in the bread be insufficient to furnish enough gluten the bread won't rise.

Fortunately, however, wheat flour contains an excess of gluten. Everyone knows, for instance, what used to happen when mother let the bread rise too long. The pans overflowed and the bread was too light. By reason of this fact, there is enough gluten in seventy-five per cent wheat flour to make a light loaf *if* all of it or nearly all of it be released into the dough by breaking down as many of the starch cells of the flour as possible, particularly if care be taken not to knead the gas out by improper handling. In the words of one baker, "The call was for high power mixers that would not expel the gas. The theory was to use the dough a little 'younger,' whip hell out of it, and bake it quickly."—*The Nation's Business.*

THE AIR LIFT HELPS ARTESIAN WELLS

By E. R. Conant*

Haphazard location of the river station group of artesian wells at Savannah, Ga., put in use in 1887-1889, resulted in a supply which soon became inadequate and led to the sinking of the Gwinnett group. The last-named artesian well system was designed by Thomas F. Johnson, Chicago. The 25 river wells were put down at random over an area of 10 acres. The 12 Gwinnett wells were sunk 300 ft. apart on a line at right angles to the direction of the subterranean flow. The Gwinnett wells have a diameter of 12 in., a depth of 500 to 600 ft. and are cased down into rock, some 250 ft. The wells are connected with a 6-ft. brick conduit 10 to 16 ft. below ground level, which discharges into a small well from which water is pumped directly to the distributing mains.

The first artesian wells in the Savannah district antedated the river station wells by five years. The water from these wells rose to from 30 to 35 ft. above mean low water. There are no early records of the static head in the river station wells but their diminution in yield indicates that the head was lowered 20 to 25 ft. within three years of the time they were put in use.

The Gwinnett wells are 3900 ft. from the river wells. When the first of these were sunk in 1890 their static head was about 28 ft. above mean low water. In 1893 the head was 12 ft. lower, and in 1898 it was 5 ft. lower still. There is no record of the head when the air lift was installed in 1902. In fact, the static head was not carefully determined until 1915, when the writer found it to be 10 to 12 ft. below mean low water—a drop of 22 ft. in 17 years, or an average drop of something less than 1½ ft. a year.

When the 12 wells at the Gwinnett station were put in use, in 1892, they yielded, by natural flow, 10,300,000 gal. a day. This fell to 9,500,000 gal. in a year or two; to 5,500,000 gal. by 1895 and to 5,000,000 gal. in 1900, where it remained until the installation of the air lift in 1902. Tests made by the author in 1915 showed a daily yield of 15,000,000 gal. At present 8 of the 12 wells yield 10,000,000 gal. a day.—*Engineering News-Record.*

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*Chief Engineer City of Savannah.

"HISSING" AIR COMPRESSORS MAKE WOOD "CARVINGS"

[The following account of an unfamiliar operation comes to us from the always beautiful and interesting **Edison Monthly.** We feel compelled to suggest that the hissing of the compressors does not speak well for their operative efficiency.]

The reader, like the rest of confiding humanity, has marvelled perhaps at the amount of wood carving that shows today on portrait frames, mirror frames, lamp standards, mouldings, and all this gilded orgy of foils and curlicues. Without doubting its genuineness for a moment, the average mortal has wondered where in the world so much and so excellent carving could possibly come from.

While there are several sources, one at least—and an electrical one—is found shaping and pruning away in West Thirteenth street.

Though knives, broad bladed affairs a foot long, have something to do with it, the "carving" in this case is done on an upper floor to the tune of the hissing of motor driven air compressors. That is to say, the wealth of delicate detail that is made here, later to be mounted on wood, is formed under pressure in wooden moulds. The substance itself is a secret mixture closely resembling putty in color and consistency. A liberal lump is placed in a mould and the whole is set on the pan of one of the presses. In a moment down comes the upper pan with some thousand pounds force, and when the pressure is released and the composition freed, there are your curls and rosettes as natural as life.

The knives spoken of shave these carvings from their pasty background as they are needed, and skilled fingers fit them foil by foil to the wood work awaiting them. A little gluing, a little more shaping, and the moulding is "carved" to the sum of artistic completeness. Some actual carving—and very fine work, too—is produced here, yet by far the most is accomplished in the manner described.

Another new oil well has just been brought in in the Alamo district, near Panuco, Mexico, which at a depth of 2115 ft. yields about ten thousand barrels daily. The first indication of oil was encountered at 1860 ft.

WE'VE GOT TO DO WHAT WE CAN

Said Michael O'Leary to Patrick McCreery,
"You sure make me weary the way that you work;
Last week you lost one day, and this week—on Monday—
You laid off completely. Bedad, ye're a shirk!"
Said Patrick McCreery to Michael O'Leary,
"Well, what if I did?—and I did, it is true—
If I grab off a play-day or two around pay-day
I guess it's my business and nuthin' to you!"

Said Michael O'Leary to Patrick McCreery,
"Me son is a soldier who's fightin' in France;
He's got to have trifles like helmets and rifles,
Or else with the boches he won't stand a chance.
He needs to have batteries—guns that'll shatter his
Enemy's trenches before an attack—
And motors to carry his camp commissary
And ships that'll bring him the things he may lack.

"But when you are shirkin' yer job, or ain't workin',
You're holdin' him up on his arms and supplies;
For, get this straight, neighbor, when you slack your labor
You're doin' more harm than a half dozen spies.
Ther's need for the keenest of work—each machinist
And fireman and blacksmith should stick to the job
In war-time conditions to make the munitions
To help smash the Kaiser and all of his mob.

"And so," said O'Leary, "your ways make me weary;
You throw down me son as he fights Over There;
To loaf is a bum thing—you bet it means something
To me when you're slackin' from doin' your share!"
Said Patrick McCreery to Michael O'Leary,
"I never have thought of it that way before;
But now that I see it I sure will agree it
Ain't me that'll loaf on the job any more!"

—*American Machinist.*

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OUR DETERMINATION

"There can be but one issue. The settlement must be final. There can be no compromise. No half-way decision would be tolerable. No half-way decision is conceivable. These are the ends for which the associated peoples of the world are fighting and which must be conceded them before there can be peace:—

"I. The destruction of every arbitrary power anywhere that can separately, secretly and of its single choice disturb the peace of the world; or, if it cannot be presently destroyed, at the least its reduction to virtual impotence.

"II. The settlement of every question, whether of territory, of sovereignty, of economic arrangement or of political relationship, upon the basis of the free acceptance of that settlement by the people immediately concerned, and not upon the basis of the material interest or advantage of any other nation or people which may desire a different settlement for the sake of its own exterior influence or mastery.

"III. The consent of all nations to be governed in their conduct toward each other by the same principles of honor and of respect for the common law of civilized society that govern the individual citizens of all modern States in their relations with one another, to the end that all promises and covenants may be sacredly observed, no private plots or conspiracies hatched, no selfish injuries wrought with impunity, and a mutual trust established upon the handsome foundation of a mutual respect for right.

"IV. The establishment of an organization of peace which shall make it certain that the combined power of free nations will check every invasion of right and serve to make peace and justice the more secure by affording a definite tribunal of opinion to which all must submit and by which every international readjustment that cannot be amicably agreed upon by the peoples directly concerned shall be sanctioned.

"These great objects can be put into a single sentence. What we seek is the reign of law, based upon the consent of the governed and sustained by the organized opinion of mankind."

OUR PRESIDENT.

THE NAVAL CONSULTING BOARD IN ITS RELATION TO THE NAVY DEPARTMENT

Speech by W. L. Saunders, American Institute of Mining Engineers Dinner, Washington, D. C., June 21, 1918.

I have been given ten minutes to speak of the Naval Consulting Board; five is quite enough. I speak, alas, as one of experience when I say that a single sentence on this subject might stir up more trouble (for the speaker) than a ton of T. N. T. About a year ago, when I was only a freshman, serving the Government for glory and a dollar-a-year, I let fall a prophesy. Prophesy is dangerous tramping ground for the tenderfoot. I said that American inventive genius would solve the submarine menace and that the Naval Consulting Board had already made substantial progress in that direction. Forthwith I fell into the hands of the Philistines—in modern times called newspaper reporters. When it was all over and I had recovered consciousness a Red Cross nurse seemed to be holding a glass of Jersey lightning to my lips. There is a story of an English Tommy who was convalescing from his first dose of trench warfare. A visitor at the hospital asked him to describe the wonderful sensation of being in a battle. He said, "First you 'ear an 'ell of a noise, then you 'ear the nurse say, 'You better drink a little of this.'"

Well. I fear that the German submarine, like the liar, the thief, the murderer and the rattlesnake, will be always with us in this war; but thanks to the English and American navies, aided by civilian workers, this dishonest practice no longer threatens starvation or disaster to civilized nations. The British Prime Minister is my authority for the statement that the submarine is no longer a menace, but is still a nuisance. Mr. Arthur Pollen adds that it is an awful nuisance. I should call it a damnable nuisance.

As to the part taken by the Naval Consulting Board, I quote from the recent Annual Report of the Secretary of the Navy:

"The work of the board, organized and approved by Congress in 1915, has increased very materially in importance and volume. Some time before the active entry of this country in the war the board called a special meeting to which were invited some fifty of the leading scientists and industrial managers, whose special study fitted them to advise on the methods of meeting the submarine problem. Plans were immediately made to investigate every field to develop a means of preventing destruction of vessels and of defeating the U boat. The investigation was divided according to the experience of the different members and associated scientists; and with the co-operation and valuable assistance of the various manufacturing companies interested, a highly developed system of team work has been attained and results accomplished not dreamed of at the beginning of the war," and again, "Valuable assistance has been rendered merchant shipping by the board's activities. Through its initiative, counsel and work the U. S. Shipping Board formed its Ship Protection Committee, taking over the study of the protection of merchant ships, and to this Committee was detailed one of the Consulting Board's most experienced members qualified in shipbuilding and with sea experience. In this field the board's work has resulted in materially reducing the shipping risk, with a consequent lowering of marine insurance rates."

The board has stimulated interest in war problems. It has stirred a patriotic spirit and effort among inventors. More than 65,000 suggestions and plans have been considered and acted upon.

Our relations with the bureau chiefs and other officers of the Navy are most cordial. Individual members of the board, like naval attaches, are from time to time called into action to aid an executive in designing or building something of value in the war service. While there are many standing committees covering different fields of scientific work, yet each member is a committee unto himself in co-operating with naval officers.

Through the vision of Secretary Daniels this board was created about one and a half years before the United States entered the war. This act of early preparedness resulted in the survey and listing of all the manufacturing industries of the country—a useful thing which had not been done before. That survey fully card indexed is now serving its purpose, bringing promptly and efficiently all the resources of the nation to the aid of the Army and Navy.

More than this should not be said at the present time of the work of this board. If any one would like to ask questions I shall be glad to answer them—after the war is over.

THOSE RIVETING RECORDS

It would really seem that somebody should be saying something about these astonishing riveting records which are tumbling over each other in the daily press. We all know that for the winning of the world war the supreme demand is for ships. In the building of the ships the most responsible and the most continuously repeated operation is the riveting. Therefore, of course, speeding up the riveting is speeding up the building and increasing the output of ships.

It is, at first thought, most gratifying to note that a lively rivalry is current throughout the shipbuilding plants on both sides of the Atlantic for the making of riveting records, these being taken, of course, as indexes and guarantees of shipbuilding speed. They may be; but are they? It was said of the Charge of the Light Brigade that it was very brilliant but it was not war. So, without questioning at all the veracity of the current riveting records, we are tempted to say that they may be very brilliant but they are not shipbuilding, if indeed, they can be called riveting.

A shipbuilding pneumatic riveting record is not the record of one operative alone handling a single pneumatic riveter, even with changes or replacements of the tool from time to time. The man usually will be the head of a cooperating gang of six, comprising, besides himself, a backer-up, two heaters and two passer-boys. The making of a pace-making riveting record involves also many more than this riveting gang, who alone get the credit. As suggesting the mass of coincident work involved it is to be noted that the holes must be instantly and constantly ready for the rivets, so the numerous sheets and other members must be successively assembled and clamped in place with all the holes matching absolutely so that every rivet will enter without hesitation, and to make sure of this a plug must be tried in each hole and many of the holes must be reamed. These preliminary operations must all be carried on without getting at all in the way of the riveters. With all these conditions suggested to be complied with, and remembering the minor interruptions which inevitably occur, we are invited at the present writing to believe that in nine hours a single riveter has driven a number of rivets amounting to one every six seconds for the entire period. It paralyzes our believing apparatus.

It would seem to be very difficult for us ever to accept records of individual riveters, such as those now current, as assurances of ultimate shipbuilding speeds. Riveting records of another class are now coming along more deserving of serious consideration. These are the collective records per week, or other period, of all the rivets driven by all the riveters employed upon a single ship or upon a single shipyard way. This would tell us a real story of real shipbuilding, and the record would really tell not only of the actual performances of the riveters but of the co-operation of all hands to produce the desired results.—*Frank Richards in the Iron Age.*

SOME RECORDS

A crew of 75 men at the St. John's shipyard recently caulked the hull of a schooner from keel to light load line and full length, 240 ft., in 8 hours.

A planking gang at the U. S. Shipping Board Yard, Jacksonville, Fla., in one day recently put in a total of 72 planks. There are 108 strakes of 16 planks each all around the ship, making a total of 1,728 planks in all. At the rate of 72 planks a day it would take a crew only 24 working days to complete the planking of a vessel.

A speed record for framing was made recently at the Portland yards of the Supple-Bollin Shipbuilding Co. A crew of 14 framers, 2 foremen and 4 riggers built and placed in position from lumber in the yards, 89 frames in 40½ hours. These frames, being double, were built, bolted together with 64 screw bolts in each frame, and two coats of carbolineum were applied before bolting together. At the same yard two gangs of five men each planked complete a 310-ft. hull, including garboard, 53 strakes of planking, in 27 days.

An attempt was made on 27th inst., at J. Crichton and Co., Limited's Shipyard, Saltney, near Chester, England, to establish a record for *hand* riveting. The squad engaged —Oakes, Edge and company—commenced at

6 a. m., intending to work in three shifts of three hours each. The weather was fine but hot. At 2.30 p. m., however, officials of the Boilermakers' Society intervened and stopped the men after 6½ hours' work. During this period, 2,007 ⅝-in. steel rivets had been driven into frames for ships' sides. When stopped, the men were perfectly fresh and very disappointed at not being allowed to complete the nine hours' record. An inspecting officer was present and the work was carried out to his satisfaction.

Driving 12,209 rivets in nine hours into a standard ship was the feat accomplished at the yards of Workman & Clark, Belfast, Eng., recently by John Omir, who beat the hour record for the United Kingdom. In his work Omir drove in more than a thousand rivets every hour and on two occasions passed the 1,400 mark. In his best minute he drove 26 rivets. Omir used about two and one-half tons of metal.

Concerning the item immediately preceding, it would be convenient to be permitted to employ the familiar dictum of the ladies—"Too ridiculous for anything."

PROGRESS OF LIQUID OXYGEN EXPLOSIVES.

Owing to the shortage of ordinary explosives for mining purposes in Germany, due to war requirements, considerable extension has been given to the development of oxyliquite, or "sprengluft" (explosive air). Several firms in Germany, working Linde's and other patents, have experimented with apparatus and effected considerable improvements in the practical application of the system for mine blasting. *Le Génie Civil* for June 1st describes some of these developments, and the following notes are taken from that journal.

The principal firm interested in the process is the Sprengluft Gesellschaft m.b.H., which has lately developed plants capable of supplying 10 kilos. (22 lb.) of rectified liquid oxygen per hour. The net cost price is said to be something under 2½d. per kilo., including interest and depreciation charges.

For storing the liquid oxygen, a modification of the Dewar flask is used, and is generally constructed in brass or very thin steel. In order to maintain the rarefaction of the space between the two walls, this space is filled up with charcoal. When the vessels are filled, the temperature between the two walls is—190 deg. Cent., the normal boiling point of liquid oxygen. The porous charcoal absorbs any small amount of gas which may escape through the pores of the metal.

In utilizing the liquid oxygen for explosive purposes, a number of combustible materials have been tried, but lampblack has been found to be the most satisfactory. In practice, cartridge cases of convenient sizes for insertion in the bore-hole are prepared in cardboard, into which the lampblack is introduced. A long tube (also of cardboard) is let into the case and through it the oxygen is poured. The most satisfactory way of charging the cartridges is to immerse them for some time in a tank containing the liquid oxygen so as to allow them to become thoroughly impregnated. The cartridges are constructed in such manner as to give as little loss as possible between the process of immersion and insertion in the bore-hole. The best types can be kept for 8 to 10 minutes after leaving the immersion tank. The cartridges are usually exploded by a small primer ignited either by a fuse or electrically, electric ignition being preferable on account of its greater efficiency.

Oxyliquite has proved very efficient in mining operations by reason of its *brisant* properties, but for the same cause it is not so suitable for quarry work. It has also been successfully used under water in the demolition of a bridge over the Danube. It is claimed that the chief company concerned with the exploitation of the process is able to supply annually the equivalent of 10,000 tons of nitrate explosives. One advantage claimed for this method is that it is safer than the explosives generally used, since the cartridge is only explosive for 10 minutes, *i. e.,* from the time it is saturated with the liquid oxygen to the time it is exploded. The only disadvantage in the system would seem to be that it is necessary to install a liquid oxygen plant near the scene of operations. The labour required to carry out the process has also to be very skilled. Comparing oxyliquite with other explosives, it is stated that dynamite has a greater density of charge than oxyliquite, but, weight for weight, the latter is more effective than dynamite.—*The Engineer.*

COMPRESSED AIR DEFINITIONS

The Compressed Air Society, 30 Church St., New York, L. D. Albin, Secretary, sends out the following definitions recommended by the Technical Committee of the Society:

Displacement.—The displacement of an air compressor is the volume displaced by the net area of the compressor piston.

Capacity.—The capacity should be expressed in cubic feet per minute and is the actual amount of air compressed and delivered, expressed in free air at intake temperature and at the pressure of dry air at the suction.

Volumetric Efficiency.—Volumetric efficiency is the ratio of the capacity to the displacement of the compressor, all as defined above.

Compression Efficiency.—Compression efficiency is the ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder as shown by indicator cards, and may be expressed as the product of the volumetric efficiency, (the intake pressure and the hyperbolic logarithm of the ratio of compression), all divided by the indicated mean effective pressure within the air cylinder or cylinders.

Mechanical Efficiency.—Mechanical efficiency is the ratio of the air indicated horsepower to the steam indicated horse-power in the case of a steam driven, and to the brake horse-power in the case of a power driven machine.

Overall Efficiency.—Overall efficiency is the product of the compression efficiency and the mechanical efficiency.

The Society further recommends that the use of other expressions of efficiency be discontinued.

UNIFICATION OF GAS WARFARE WORK

Following the recent transfer of work on war gases from the U. S. Bureau of Mines to the War Department, a further step toward unifying all work of this sort was taken by Secretary Baker in ordering that all classes of gas warfare hereafter should be under the control of the Chemical Warfare Service, commanded by Maj. Gen. William L. Sibert. Divisions in the Medical Department, the Ordnance Department, as well as in the Bureau of Mines, have been handling it in the past. All officers and men who have been connected with offensive or defensive gas warfare will now be responsible to the Chemical Warfare Service. The field-training section has been under the corps of engineers.

Defensive gas warfare has been under the control of the Medical Department. The work has consisted of the designing and manufacture of masks, both for men and animals, and the procurement of appliances for clearing trenches and dugouts of gas. Offensive gas warfare consists principally of manufacturing gases and filling gas shells. The work has been under the direction of the Ordnance Department. The new department will take over the work of chemical research for new gases and protection against known gases. All chemists now in the Army will be transferred to the new service.

HIGH AIR PRESSURE IN TUNNEL WORK

Driving subaqueous tunnels at New York is now an old story and little concerning the work gets into the papers. Nevertheless the business is as active as ever, there being four tunnels advancing under the East River at the present time. In the construction of one of these, at 60th Street, a maximum working pressure of 47 pounds, gage, has been reached. More than 25 years ago, about half a mile north of this tunnel a gas main tunnel was driven, the first of all the East River tunnels, and in that for a short time a pressure of 52 pounds was reached with a number of fatalities due to the lack of knowledge of proper treatment which has since developed.

The high pressure in the 60th Street tunnel is on account of the great depth—more than 100 feet—at which the tunnel is being dug. This low point was required because of the depth of the west channel of the East River between Blackwell's Island and the Manhattan shore. In order to cross this channel it was necessary to obtain permission of the United States Government to place a false bottom under the West Channel, which was done by depositing more than 60,000 cu. yd. of clay and riprap. The men work only two shifts of 45 minutes each in the 24 hours, and are paid, it is said, $7.50 per day. In order to keep the work going sixteen shifts of men are employed. The men in coming out spend 15 minutes in a first lock, where the pressure is reduced to 20 lb., then a few minutes are taken in walking an intermediate chamber 1800 feet in length, and 20 minutes is spent in an outer chamber where the pressure is gradually reduced to normal. Similar precautions are observed in entering the tunnel.

WHEN CARBON MONOXIDE IS FATAL

Carbon monoxide has an avidity for hemoglobin, the red coloring matter of the blood, with which it forms the same combination as does oxygen, only 250 times as powerful. However, this combination is not permanent and a man brought out to the fresh air, or to whom air mixed with oxygen can be administered, will generally recover if exposure is within the following limits. As a rough estimate, it may be stated that usually a man will die who has breathed 0.2 per cent. of carbon monoxide mixed with air which is in other respects normal, for four or five hours, or 0.4 per cent. for one hour. With from two to five per cent. of carbon monoxide death follows almost as quickly as in drowning.—*Journal of the American Medical Association.*

NOTES

Sir Douglas Haig recently celebrated his fifty-seventh birthday. An older brother, John, a mining engineer at a talc mine at Eldorado, Ontario, enlisted at the age of sixty, obtained a lieutenancy without influence, and was promoted captain. Not until he had been in the trenches for months did he meet his brother, who did not know he was at the front.

A peculiar accident caused the death of a laborer in a rock quarry at Rochester, N. Y. The man was on top of a chute, pushing stone down into a car loaded by his companions, when he lost his footing and fell. He retained his hold on his shovel and the tool caught the sides of the chute and held him, while tons of rock fell on him.

A labor-saving device now being employed at the Portland yard of the Foundation Company in Oregon, is described in the official organ of that organization as follows: "You are all familiar with the fact that salt is placed between the ceiling and planking of all wooden ships to preserve the wood above the water line. Heretofore the planking has been delayed because the salting has not been done. Science now steps forward with a new wrinkle for salting a ship. The method requires the use of an auger, a tin box, an air jet and a couple of men. A hole is bored through the ceiling outside of which a tin box filled with salt is placed, and inside the box of salt is injected the air jet. The salt is quickly blown into the many pockets formed between the ribs."

Five workmen were killed outright and another was seriously injured in an explosion that occurred June 26, in the tunnel being driven for the East Bay Water Co., Oakland, Cal., by Bates & Borland, contractors. The heading had been advanced about 1500 ft. and some previous difficulty with gas had been experienced. The five men killed were working at the heading; the sixth man, operating a storage battery locomotive, was some distance from the heading. It is believed that a spark caused by the striking of a pick on rock may have ignited the gas. The explosion caused a cave-in which prevented rescuers from bringing out the bodies until the debris had been excavated.

Materials for one mile of first and second-line trenches and communication-trenches on the British front. according to C. G. Martin of the Royal Engineers, include the following: 900 miles of barbed wire for entanglements, weighing 110 tons; 12,000 standards 6 ft. high; 12,000 small pickets; 6,250,000 sand-bags, weighing 1000 tons; 36,000 sq. ft. corrugated iron; 1,125,000 ft. B. M. lumber.

Experiments are now being made in Norway to operate automobiles with acetylene gas. No gasoline has been obtainable for many months, and practically no automoblies have been running. If the motors can be made to use acetylene gas, it can be manufactured in considerable volume from calcium carbide, which is produced in large quantities in Norway by means of the water power.

The temperatures attained in the cylinders of gas-engines may vary considerably, but in some instances, at the top of the explosion-stroke, the temperature is 2,700 degrees F., with a minimum, during suction-stroke, of 250 degrees, and an average of 950 degrees during the complete cycle. These are the temperatures of the gases in the cylinder, not of the cylinder-walls.

A tunnel a mile long will be a novel feature on the highway to be built between Clark's Summit and New Milford, Pa. The road will be built upon right-of-way released by the D., L. & W. Railroad Company.

Mosquito reduction, which is rightly receiving considerable attention, but deserves far more, is primarily an engineering problem. The first point of attack should be the removal of breeding places by drainage. Oiling is a mere palliative, although often necessary until drainage can be effected or where for any reason it cannot be successfully carried out. Successful control under the most trying conditions shows that there is no excuse for the mosquito pest and danger in this country.

According to the *Electrical Experimenter*, all institutions depending upon the Marion (Ind.) Electric Light and Power Service were without current for a minute recently, and all because John Coats, who takes his regular Saturday evening bath at his home, got hold of a live wire in attempting to shake into life a defunct electric-light globe, and could not let go. Standing in the water with a 110-volt current coursing through his body, all Coats could do was to yell for help. A neighbor quickly discovered his plight, and telephoned the light company, who turned off all current. Coats was injured only in feelings.

The total power now being generated on both sides of Niagara is 653,500 h.p. Of this amount 265,000 h.p. is generated in the United States, which also receives 110,000 h.p. exported from the Canadian side, making a total of 375,000 h.p. available in the United States. This amounts to 40 per cent. more for the United States than for Canada, although the latter country generates 100,000 h.p. more than the United States. There is no intention on the part of either the Canadian Government or the Commission to interfere with the present export arrangement, even though Canada is now short 100,000 h.p.

Condemnation of well waters as the result of inspections and analyses by the Illinois State Water Survey for the nine-year period from 1907 to 1916 shows that as the depth of the wells increases the percentage condemned as unsafe decreases. During the period named 11.281 wells were examined and of these 5,091, or 45 per cent, were condemned. For wells less than 25 ft. deep the percentage of condemnation was 74; 25 to 50 ft., 63; 50 to 100 ft., 36; more than 100 ft. deep, 14. Of wells with unknown depths the percentage of condemnation was 44, the total number of wells being 636.

The Channel Tunnel, said Sir Arthur Fell at a meeting of the London Society, will be the earliest and greatest of all the works of peace which will be begun immediately the war is over, and when labor and materials have become available. It will be the first monument to the new era of peace, and to an enduring friendship with the immortal race which for four years has been fighting by our side for the liberty of the world. This link will unite the two nations in a permanent bond that will enable the two peoples to know each other better, and to appreciate one another more.

Dr. Charles P. Steinmetz, of the General Electric Company, predicts the ultimate use of all the hydraulic power that can be generated at Niagara. His suggestion is that Niagara should be developed completely, say, to about 10,000,000 kw., making the falls run dry; but that the power plants should be shut down, say, to 10 per cent. of full capacity, on holidays and Sundays, allowing the falls to resume their natural form for the benefit of visitors. The recent experiences in fuel and power shortage, and the possibilities of railway electrification and electro-chemical and electrometallurgical work, will sooner or later force all to agree that some such scheme is demanded in the national interest.

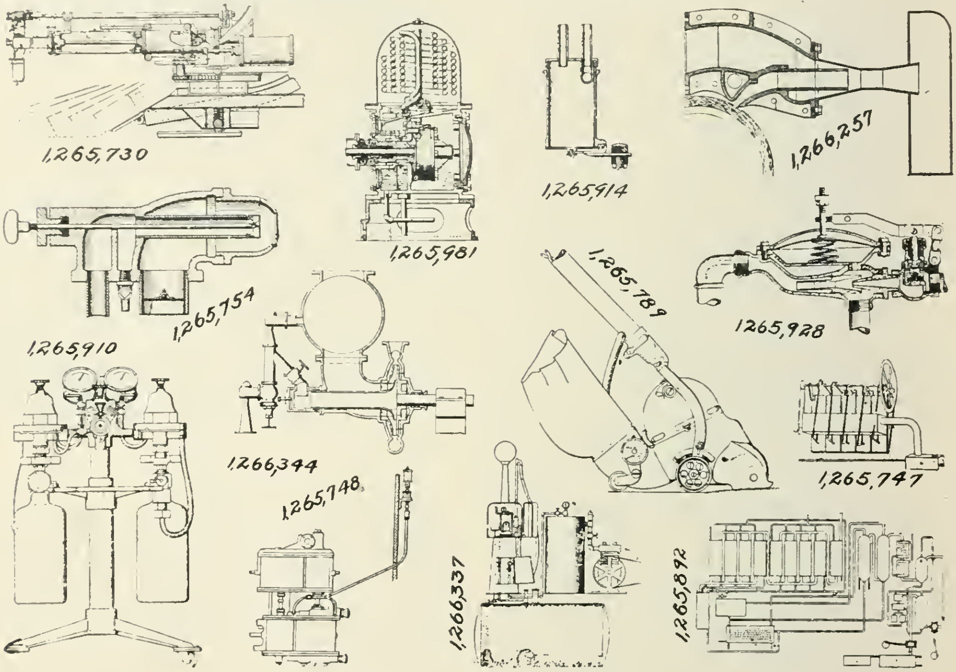
LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 14

1,265,730. LOADING OR MINING AND LOADING MACHINE. Frank Billings, Cleveland, Ohio.

1,265,747. AIR-MOTOR. Melville Clark, Chicago, Ill.
1,265,748. LUBRICATING DEVICE. Nelson T. Cline and Robert M. Long, Pittsburgh, Pa.
1,265,754. OIL-BURNER. Albert Deem, Indianapolis, Ind.
1,265,789-10. VACUUM CLEANING-MACHINE. James B. Kirby, Cleveland, Ohio.
1,265,892. METHOD AND APPARATUS FOR SEGREGATING AND RECOVERING GASES. Frederic Augustus Eustis, Milton, Mass.
1,265,908. PNEUMATIC ELEVATOR AND DISTRIBUTER FOR COTTON-GINS. Joseph Luther Hart, Chickaska, Okla.
1,266,566. BAROMETRIC VALVE. Earl E. Eby, Wilkinsburg, Pa.
1,266,624. RESPIRATOR. Hubert H. Ramsay, Tylertown, Miss.
1,266,697. MILKING-MACHINE. Arthur C. Macartney, Chicago, Ill.
1,266,795. MILKING-MACHINE. Carl Jacob Johan Hagg, Stockholm, Sweden.
1,266,864. DOOR CHECK AND CLOSER. John C. Schmidt, Chicago, Ill.
1,266,966. HUMIDIFYING-FAN. Willard M. McEwen, Chicago, Ill.
1,266,976. VACUUM-BREAKER. Harry E. Morton, Boston, Mass.
1,267,040. FLUID-PUMP. Charles A. Anderson, Chicago, Ill.



Pneumatic Patents May 14

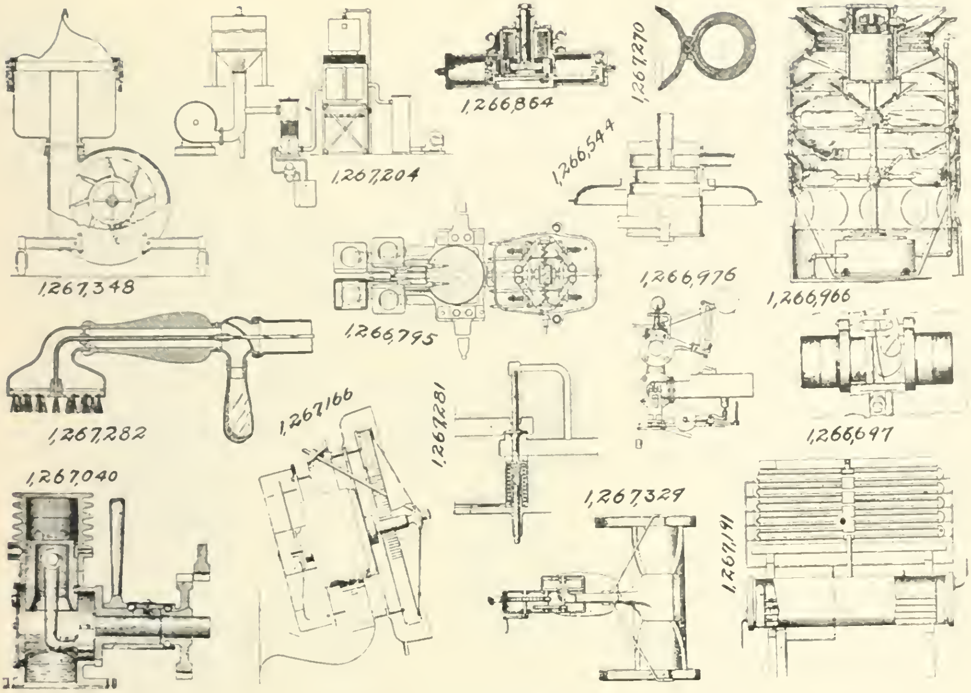
1,265,910. APPARATUS FOR DELIVERING A MIXTURE OF GASES. Jay A. Heidbrink, Minneapolis, Minn.
1,265,914. MILKING-MACHINE. Arthur V. Hinman and Ralph L. Hinman, Oneida, N. Y.
1,265,928. HEATING SYSTEM AND HYDRAULIC VACUUM-GENERATOR. Bryce W. McClymont, Detroit, Mich.
1,265,981. GAS-COMPRESSING APPARATUS. Edward T. Williams, New York, N. Y.
1,265,997. PNEUMATIC POWER-BOAT. Geo. W. Christoph, Warehouse Point, Conn.
1,266,257. SEPARATOR AND CONVEYER FOR PAPER-PULP MACHINERY AND OTHER PURPOSES. Anton J. Haug, Nashua, N. H.
1,266,337. APPARATUS FOR SUPPLYING GASOLINE AND COMPRESSED AIR. Harry F. Smothers and Emanuel E. Norquist, Kansas City, Mo.
1,266,344. CONDENSATE AN AIR REMOVING APPARATUS. Robert Suczek, Philadelphia, Pa.
1,266,482. AIR-CUSHION. Harris Kamrass, New York, N. Y.

MAY 21

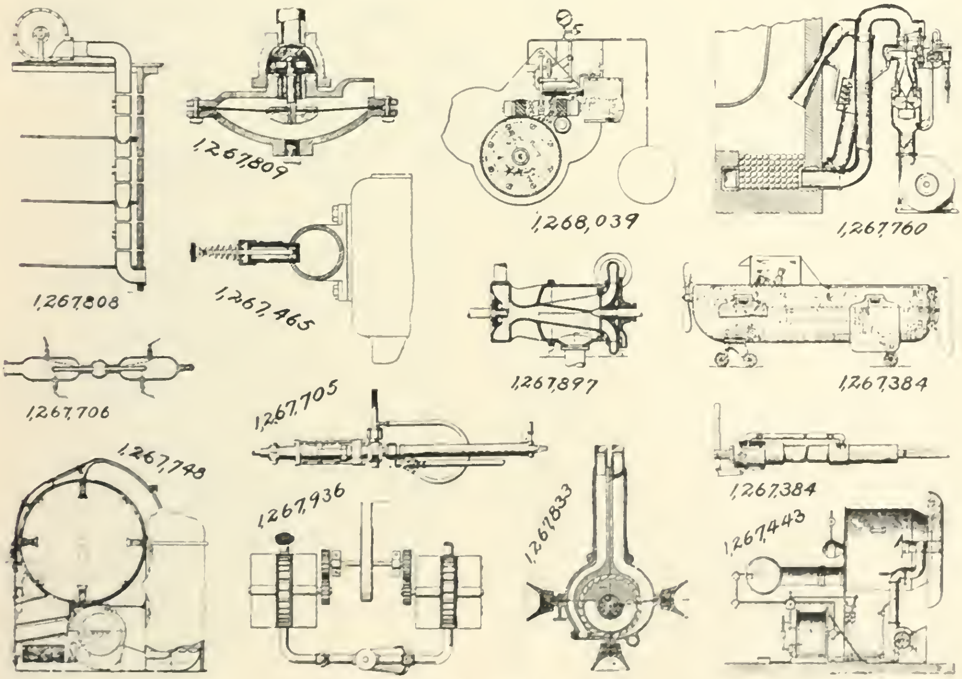
1,266,544. MILKING-MACHINE. Carl Oscar Anderson, Lancaster, Pa.
1,267,160. AIR-COOLING SYSTEM. George E. Albin, Cornish, Okla.
1,267,166. HUMIDIFIER. Frederic F. Bahnson, Winston-Salem, N. C.
1,267,191. PROCESS AND APPARATUS FOR DEAERATING WATER. Herman J. Demuth, Kiowa, Kans.
1,267,204. METHOD OF DEODORIZING GRAIN. Walther Frick, Hochst-on-the-Main, Germany.
1,267,229. ELASTIC - FLUED TURBINE. Oscar Junggren, Schnectady, N. Y.
1,267,270. VACUUM - CUP. Rudolph Paul Rheinlander, St. Louis, Mo.
1,267,281. PRESSURE - REDUCING APPARATUS FOR FLUIDS. Eugene Schneider, Paris, France.
1,267,282. VACUUM HAND-BRUSH. Jessie B. Scully, Kansas City, Mo.
1,267,329. VACUUM-SWEEPER. Jerry J. Merithew, Akron, Ohio.
1,267,348. MOBILE SUCTION-CLEANER APPARATUS. Charles D. Lanning, Boston, Mass.

MAY 28

1,267,384. FLYING-BOAT. Leonardo Crimaudo, New York, N. Y.



Pneumatic Patents May 21



Pneumatic Patents May 28

1,267,443. MEANS FOR AUTOMATICALLY REGULATING THE BLAST COMPONENTS OF PRODUCERS. Hugh T. Newell, Pittsburgh, Pa.

1,267,465. AUXILIARY AIR-INLET VALVE. John H. Schmidt, Detroit, Mich.

1,267,698. PNEUMATIC TOOL. Addo M. Roberts and Edwin G. Williamson, Greenville, Pa.

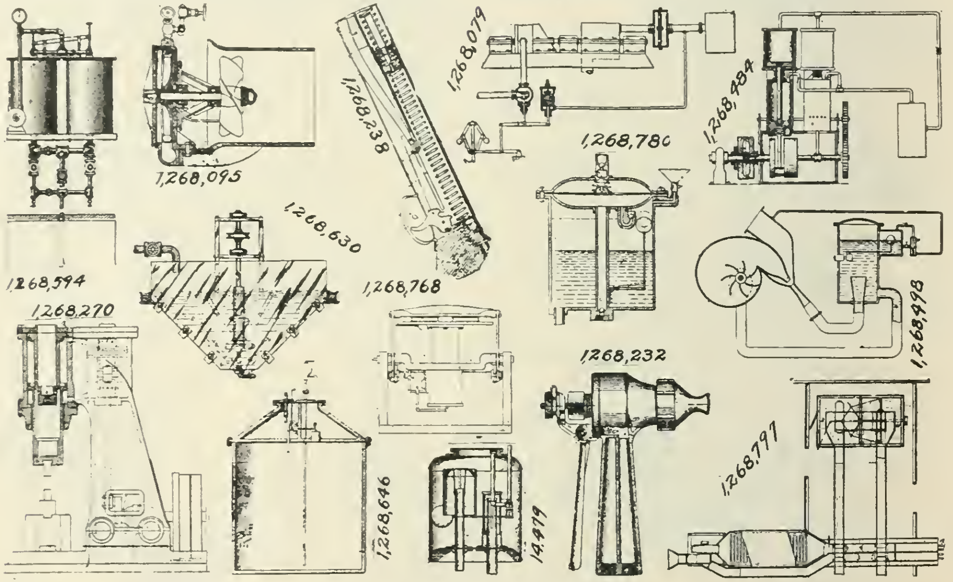
1,267,705. ROCK-DRILL. William A. Smith, Denver, Colo.

1,267,706. VACUUM REGULATION. Homer Clyde Snook, Oak Park, and Edwin W. Kelly, Chicago, Ill.

1,267,748. DRYING APPARATUS. Edward I. Cutter, Norwood, Ohio.

1,267,760. LIQUID-FUEL COMBUSTION. John Good, Brooklyn, N. Y.

3. The method of burning liquid fuels which consists in controlling the liquid fuel and air in the proportions of an explosive mixture of such liquid fuel, heating said proportioned air and then finely atomizing and mixing the proportioned liquid therewith to form a blast mixture, and directing said mixture against a combustion-locating bed at a velocity, between its place of formation and said bed, which exceeds the rate of flame propagation through said mixture, whereby the locus of the combustion is established and maintained in or on said bed.



Pneumatic Patents June 4

1,267,808. DEVICE FOR VENTILATING HOTELS AND OFFICE-BUILDINGS. William R. Self, Newton, N. C.

1,267,809. VACUUM-VALVE. Wilfred Shurtleff, Moline, Ill.

1,267,833. FLUID-ACTUATED VIBRATOR. Charles P. Wilson, Chicago, Ill.

1,267,880. CENTRIFUGAL COMPRESSOR. William J. McBride, Lynn, Mass.

1,267,897. AIR-PUMP. Gustav Pagel, Berlin, Germany.

1,267,936. HYDRAULIC AIR-COMPRESSOR AND MOTOR. Christian Carl Tuch, Honolulu, Hawaii.

1,268,039. PNEUMATIC STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. John E. Miller, Moline, Ill.

JUNE 4

1,268,079. REGULATING MECHANISM FOR CENTRIFUGAL COMPRESSORS. Otto Banner, Easton, Pa.

1,268,081. FLUID-OPERATED PERCUSSIVE TOOL. Lewis C. Bayles, Easton, Pa.

1,268,095. TURBINE FAN-BLOWER. Charles T. Coe, Kearney, N. J.

1,268,128. MEANS FOR SUPPLYING AIR TO GAS-ENGINES. Charles L. Kurtz, Columbus, Ohio.

1,268,232. SPRAYING DEVICE. George B. Furman, East Orange, N. J.

1,268,238. AIR-GUN. William B. Greenleaf and Ernest S. Roe, Plymouth, Mich.

1,268,270. FLUID-POWER HAMMER. Ralph W. Nazel, Philadelphia, Pa.

1,268,272. ELASTIC-FLUID TURBINE. Earle R. Newton, New York, N. Y.

1,268,403. AIR-BRUSH. Ernest C. Stacker, Philadelphia, Pa.

1,268,434. PNEUMATIC ENGINE-STARTER. Barney Christiansen, Slater, Iowa.

1,268,467. PRESSURE CONNECTION AND GAGE. Carl I. Jacobson and Alfred L. Fowler, Los Angeles, Cal.

1,268,498. PUMP OR COMPRESSOR. Arthur Edwin Leigh Scanes, Ashton-on-Mersey, England.

1,268,594. APPARATUS FOR ELEVATING LIQUID. James A. MacKenzie, Rochester, Pa.

1,268,630. AERATING DEVICE. Joseph P. Ruth, Jr., Denver, Colo.

1,268,646. LIQUID-FOUNTAIN. Adolf P. C. Urbin, Jr., Mount Vernon, N. Y.

1,268,738. ELASTIC-FLUID TURBINE. William J. A. London, Springfield, Mass.

1,268,768. MOLDING-MACHINE. Emlen P. Pitfield, Cambridge, Mass.

1,268,780. VACUUM FEED DEVICE FOR ELEVATING LIQUID. Webb Jay, Chicago, Ill.

1,268,797. APPARATUS FOR DRYING AND THE LIKE. August Tegoli, San Francisco, Cal.

14,479. (Reissue). AIR-LIFT-PUMP BOOSTER. Frank S. Miller, deceased, Indianapolis, Ind., by William Langsenkamp, Jr., trustee, Indianapolis, Ind.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxiii SEPTEMBER, 1918 No. 9

COMPRESSED AIR TO WIN THE WAR

By Frank Richards

When the great world war shall have been won it will not be easy to prove that it was won by compressed air, but it is easy enough to demonstrate upon the spot, and before we leave this printed sheet that the war cannot be won without it, which should go far toward proving the whole.

Few can realize how dependent are our modern activities, whether in peace or in war, upon the aid of compressed air, perhaps not so much directly as indirectly, but just as truly in either case. It would be a good thing for all hands to know a little more about how compressed air got under way, how it acquired its momentum, and the gait it is now traveling. A little looking into the history of compressed air in its modern uses and adaptations, what it has done and what it is doing, should stiffen our faith in its power of accomplishment, and its history is one of the shortest.

The career of compressed air as we are now indebted to it begins with the rock drill as its principal dependent, although not one-tenth of the air compressed in these days goes to the driving of rock drills, but the rock drill still suggests the easiest way of getting acquainted.

In all great engineering undertakings, such as the building of canals and railroads, and especially the construction of great aqueducts either for water power transmission or for municipal water supply, there is always involved the cutting and removal of masses of rock, this up to as late as the middle of the nineteenth century, having all to be done by hand drilling, with black powder for the blasting.

Now, rock drilling by hand, one man holding a chisel or bit and occasionally lifting it and turning it a little, with two men striking it with sledges, is a slow and tedious process, and, moreover, prohibitively costly beyond narrow limits, so that engineering works before the coming of the air driven rock drill were located so as to avoid rock cutting as much as possible, and were planned and laid out quiet differently from the lines that would be followed in these days.

This same handicap gave many crooks and twists and miles of them unavoidable length to the earlier railroads, some of which have since been straightened and shortened by, we might say, the air driven rock drill. The Boston and Albany, one of the earlier American railroads, was built under the primitive conditions. It followed the tortuous windings of the streams and climbed the steep hills of Western Massachusetts. Its phenomenal prosperity led to the planning of a competing road with straighter lines and easier grades, but—and a big but it was in those days—with the Hoosac Tunnel to bore.

This Hoosac tunnel proposition must have been more or less a trusting to luck, for the means of driving a 4¾ mile tunnel through hard rock were not then in sight.

Hand drilling was started on the job, and the so-called tunneling machines of optimistic inventors demonstrated their failures. The delay and the apparent hopelessness of the task became a by-word, so that the dear old Autocrat of the Breakfast Table, in his "Latter Day Warnings," could write:

When the first locomotive's wheel
Rolls through the Hoosac tunnel bore
* * * * * * * * *
Then order your ascension robe.

THE ROCK DRILL ARRIVES

But then along came the air-driven rock drill, so well thought out and worked up that with little preliminary experimenting or adjusting it was an immediate success. It began to walk right into the rock at once, and when it got fully under way, with the other arrangements co-operating, the tunnel was driven to completion. The tunnel at once advertised compressed air and the rock drill all over the world. Europe soon so developed the tunnel habit that the time records for tunnel driving have kept on the other side of the Atlantic ever since.

Besides the Hoosac tunnel, and the endless string of other tunnels which had been unknowingly waiting the coming of the rock drill, there was next the entire mining field. Mining, as we know, is entirely a rock cutting proposition, and the rock drill at once and completely "filled the long felt want."

The air-driven rock drill now completely dominates this field, so that it is the simplest statement of fact to say that not only our silver and gold but also all the baser metals—except a pile of iron ore that they dig with a shovel—are obtained by the persistent activity of the rock drill.

CAN'T LIVE OR FIGHT WITHOUT IT

So, then, when we can live and when we can carry on war without coal and copper and iron, without lead and zinc—not mentioning silver and gold—and all the things the rocks hold for us, then, and not until then, can we do what we will without compressed air; and there is the proposition with which we set out completely established.

But that is only the beginning of the story, and it would not be fair to compressed air, or to those who ought to know about it, to leave it there.

THE APPRENTICE DAYS OF COMPRESSED AIR

The history of the water supply of New York city is interestingly connected in various ways with the history of the rock drill and the development of compressed air practice. The first Croton aqueduct, completed in 1842, had no help in its building from the air driven rock drill, and consequently on its entire line which traversed the surface of the ground as much as possible—taking seven or eight additional miles of length to do it—the number of short tunnels which were unavoidable aggregated only 4 per cent of the entire length. To carry the water over the Harlem River at nearly hydraulic grade High Bridge was built, the finest example of all stone construction the metropolis can boast.

THE "NEW" CROTON AQUEDUCT

When the New Croton aqueduct was built—1885 to 1890 for the actual building of it—the rock drill had come into its own and was ready to tackle anything, even the 33 miles of continuous tunnel proposed, the longest tunnel even thought of up to that time, so the new water tube was carried deep down in the solid rock all the way; and to pass the Harlem there was no high bridge, but a siphon went down 300 feet below the river and up again on the other side.

A TUNNELING SCHOOL

Although the air driven rock drill had already proved itself a great success, and was busily employed in all the great mines, the limits of its capabilities were as yet unknown, and the details of practice for its most profitable employment were yet to be determined, and probably no better opportunity for anything of like importance ever occurred. So that the work might be carried along as fast as possible there were 40 shafts, giving 80 faces of rock to work against, and the several sections were let to competing contractors, all striving to surpass each other and especially to realize the greatest profit. Here was a practical rock cutting and tunneling school for the whole world. It may be well to note a few, and only a few, of the things there was a chance of learning.

Rock drills when working in the open have frequently been driven by steam, but in mining and tunneling steam is too much of a nuisance and cannot be tolerated and air takes its place. The job of the air compressor, therefore, would seem to be extremely simple. It is only to pump or compress a sufficient quantity of air and to keep the pressure high enough.

LEARNING ABOUT AIR COMPRESSION

But there proved to be much to learn about the compressors as well as about the drills. When you compress air it gets very hot. If it is at average atmosphere temperature, say

60 degrees, when you begin to compress it, the temperature will be 432 degrees after compressing the air to say, 80 pounds, which is what the drillers call for. This means that its temperature will have been raised by an amount equal to about twice the difference between the freezing point and the boiling point of water. Then if you are liberal in the use of oil for the machine, which, being interpreted, means extravagantly wasteful of it, not a drop of oil will be destroyed or disappear but will be carried along by the compressed air and be deposited in the air receiver, and the hot air will be quite apt to set it on fire. On this aqueduct work air receivers sometimes got red hot, actually and visibly red, from the fire inside.

The air, although made so hot by the compression, would, unless the oil took fire, cool very rapidly as it flowed along in the pipe, so that generally when it reached the drill the excess of heat would be all gone, and then the air as it expanded in doing its work in the drill would become intensely cold, and the moisture which is always present in the air, would freeze and accumulate in the passages of the drill and choke them up, so that the drill would not work until it could be thawed out. Experiences of this character led to improvements in air compressors and in compressed air practice, and the machines became gradually standardized, efficiently reliable, and ready for the great tasks before them.

The drills on the job also went through their course of training and were tried out in all their details. The size and power best adapted to the work were to be proved, the best materials for their construction, the reliability of their operating mechanism, rapidity of wear, ease and quickness of repair, facility of setting up, pulling down and moving about. Absolute duplication of parts began to be insisted upon and standardization became more and more complete.

Another exacting lesson had to do with the bits or steels which actually did the rock cutting, as to the most reliable brands of steel and methods of forging, hardening and tempering, the most effective shape for the bit, the number of cutting points, the acuteness or bluntness of the angles.

But however effective may be the drills, success must ultimately depend upon the actual drilling and the blasting. The number and location of the holes for the face of rock attacked are to be determined, the proper diameter of the holes, their depth and the angle at which they shall be drilled.

Then in the blasting also there is a carefully planned system to be followed, as to the kind of explosive to be used, the sizes of the cartridges, the order in which the holes are to be fired, as not all are exploded at the same instant. In tunnel work it is generally arranged that not the entire tunnel section is worked at once or with one gang of men. A certain portion, a heading, sometimes at the top and sometimes at the bottom, being driven a considerable distance in advance of the rest. Then at the same time another gang may be working at the remaining portion. This not only carries the entire work along so much faster, but it provides better for the getting away of the muck. To time and arrange all the operations so that they will interfere as little as possible with each other, and so that all may have sufficient time for their specific work is no simple task. In all the particulars suggested the second Croton aqueduct was a worker-out of many problems whose solutions were greatly to the advantage of the succeeding generations of engineers.

THE DIFFERENT LESSONS OF THE THREE AQUEDUCTS

The three successive aqueducts built for the water supply of New York, although not very far apart in point of time, mark three distinct periods in engineering practice.

The first Croton aqueduct was an example of the engineering practice of the olden times. It was built entirely without the aid of compressed air, so we have no more to do with it in this connection.

The second or the "New" Croton aqueduct was, as we have seen, indebted entirely to compressed air for its existence, but it was after all, at least in one respect, a rather crude construction. No attempt was made in the tunnel as a whole to have it perfectly water tight. The interior surfaces of the rock excavation were allowed to remain just as the explosives had left them. On the completion of the tunnel, in testing it for leakage, it was found in a certain portion of the tunnel that the leakage of water out of the tunnel amounted to a million gallons a day; but it was also found that in another part of the tunnel, where the ground was high above it, there was a leakage of water *into* the tunnel amounting to two million gallons a day, so there was little occasion to worry about that.

THE CONCRETE AGE

Before the construction of the Catskill aqueduct the Concrete Age of engineering had begun, and this aqueduct, while fully indebted to compressed air for its being, has also concrete as an essential and conspicuous element in its construction. This aqueduct, with a total length of 120 miles, and with its main sectional area greater than that of both of its predecessors, required under its various contractors 65 large air compressors, never all in service at once, with an aggregate capacity of 100,000 cubic feet of free air per minute, one of the compressor installations being at the time the largest in the world. The compressed air in this aqueduct work was employed, besides for the driving of rock drills, in such a variety of ways that it is not easy to enumerate them. There was the pneumatic conveying and depositing of large masses of concrete and also the thin laying and building up of concrete over large surfaces by the cement gun. The air lift was used for unwatering a shaft and other purposes. The pneumatic caisson was employed for shaft sinking, and men worked in air pressure in driving the tunnel under a swamp. Then pneumatic drilling, riveting and calking tools were called for where steel tube construction occurred.

BARGE CANAL

In the building of the New York State Barge Canal it might have been expected, as it was entirely an out of doors job, that steam would have been employed throughout, and that compressed air would have had no chance at all. But air did have a chance here also and showed another phase of its adaptability. Advantage was taken of available electric current, generated by water power and transmitted considerable distance, to drive air compressors located near the work. The compressed air thus produced took the place of steam entirely at many points and did all the work of steam, operating rock drills, rock crushers, hoists, conveyors, pumps, and doing the work more cheaply, or it would not have been employed.

Some special work which only compressed air could have done came along incidentally. For instance, in one case it was found that there was a serious leak, due to a stratum of defective rock, under the walls of a lock after its completion. To cure this leak a tunnel was driven, in regular subaqueous, pneumatic tunneling style, under the walls and end of the lock, thus removing the defective portion of rock, and then the tunnel was entirely filled with concrete, and the leak was stopped.

PANAMA CANAL

While we are on the big jobs it is only proper to mention briefly the Panama Canal. Here compressed air found its opportunity again and did effective work. Along the Culebra Cut twelve large air compressors were installed in three about equidistant points connected by 14 miles of air mains with 34 miles of branches. These compressors, delivering 30,000 cubic feet of free air per minute, made world records for efficiency and high economy of operation. There were also compressor plants at two other points and also in the two great machine shops. The air was used for hundreds of rock drills, for deep well drills, for hoists, conveyors, rock crushers, and for the handling of the masses of concrete. In the shops there were all the variety of pneumatic tools in use.

THE BIGGEST COMPRESSED AIR MONUMENT

Following these three great achievements in modern engineering, the Catskill Aqueduct, the Barge Canal and the Panama Canal, in the construction of each of which compressed air bore a part so conspicuous and responsible, we came to another work vastly greater than either of these—and it is not finished yet—New York City itself. In its upbuilding in the last twenty-five years is surely the greatest of all the works of compressed air and its most impressing monument.

New York is builded upon a rock, and of late years compressed air has had the preparing of the foundations for its responsible erections. The New York Central and the Pennsylvania Stations required the excavation of enormous masses of rock, and the miles and miles of subway—the length increasing with the date—mostly cut in the solid rock, were the work of air driven drills.

Downtown, where the world famed skyscrapers are massed, the top of the primeval rock is far below tide level, and to secure sure support for the great structures pneumatic caissons are sunk to the rock surface, the men working in the caissons under the air pressure required to exclude the water, removing the superincumbent earth within as the caisson descends.

Then the driving of the several tunnels under the North and the East Rivers was entirely a compressed air job, the sand hogs here having practically continuous employment for many years past and for countless years to come. In this work two styles of air compressors are required, the one supplying air at comparatively low pressure to oppose the pressure of the water, this air being the atmosphere in which the sand hogs work, and the other delivering high pressure air for driving the rock drills and other pneumatic tools as required.

Compressed air, again, has rendered important service in New York harbor improvement, especially for subaqueous excavation at Hell Gate and elsewhere, work which promises to be greatly increased in the near future. In our enumeration we must not forget the compressed air work in preparing the foundations for the piers of the great East River bridges, including Hell Gate bridge. Besides all this are to be remembered also the great numbers of smaller pneumatic tools, hammers, drills, riveters employed in the erection of all the structured steel work occurring in all the undertakings above spoken of.

It is not necessary to offer here any figures in corroboration. In time, in labor, in money, in responsibility and effectiveness, compressed air has massed its greatest achievements in and immediately around New York, with a perpetual contract ahead. In mentioning the various services of compressed air in the upbuilding of the great city we cannot forget that the three aqueducts are part and parcel of it.

Compressed air at the same time knows neither time nor place; for wherever things are being done it is sure of its share in the work. The distribution of the air compressor's sent out by the various builders is a sufficient voucher for this, not one per cent of the machines in use being located within sight of New York.

But enough of this. It is more than sufficient to show that wherever on earth big things are being done compressed air has a hand in them, and we may be sure enough that in the biggest thing in all earth's history, the great world war, compressed air must be there in force, as we shall not fail to see.

To be concluded.

FIG. I

THE COMPRESSED AIR EQUIPMENT AT HOG ISLAND

By B. K. Price

For expediting the construction of ships at Hog Island extensive use of compressed air was recognized as a vital factor, and considerable attention was given to this phase of the work in planning the huge yard. As a result there is at Hog Island to day the second largest compressed air plant in the world, planned and built under the supervision of several of the country's most eminent engineers.

The plant was planned to supply compressed air at 100 pounds working pressure. It comprises five separate air compressor units which supply the shipways and shops, and two smaller units which supply the marginal wharf. By dividing the air compressing capacity of the yard into units and inserting valves in a main pipe running along the heads of the slips and wet basins the danger of a shut down of the entire air system is practically eliminated. The five larger compressor units are located at about the center of each of the five groups of

10 ways, while the two remaining units are along the marginal wharf, each serving half of the total number of eight wet basins. These various compressor houses also serve as high voltage substations.

Leading from each of the compressor houses along the shipways is a 12-inch pipe through which the air is fed into a 10-inch main, extending parallel to and 98 feet from the heads of the slips for more than a mile. This main distributes the air into 6-inch pipes, one of which runs on each side of the keel blocks in each slip. A tee and manifold with six outlet valves is inserted in these pipes at 20 foot intervals along the length of the keel. Another main, 6 inches in diameter and connected to the larger one, extends along the marginal wharf, a distance of over half a mile, and 3 inch branches are taken down on each side of the wet basin piers. Outlets similar to those on the building slips are inserted in these branches. Provision for expansion and inspection is made by the introduction of U bends and the use of box trenches along the main lines.

Compressed air is also used extensively by the shop group, and it is supplied by tapping the 10-inch main and leading a 6-inch branch back and across the front of the group, where suitable extensions are made to each shop.

DESCRIPTION OF EQUIPMENT

The five larger units are of identical type and each is equipped with three Ingersoll-Rand air compressors. Two of these compressors are 40 and 25½x30 inches, direct connected to a 1020-horsepower, General Electric 400-volt, 3-phase, 60-cycle synchronous motor, having a speed of 138½ revolutions per minute. The actual delivered capacity of each is 5320 cubic feet of free air per minute. The third compressor is 28 and 17½x21 inches, direct connected to a 450-horsepower, General Electric 4000-volt, 3-phase, 60-cycle synchonous motor, having a speed of 180 revolutions per minute. The actual delivery capacity of this unit is 2.275 cubic feet, making the total capacity of the plant 12.915 cubic feet of free air per minute.

DRYING THE AIR

Some of the difficulties not infrequently arising in the operation of air tools are due to the moisture in the air. This moisture on being

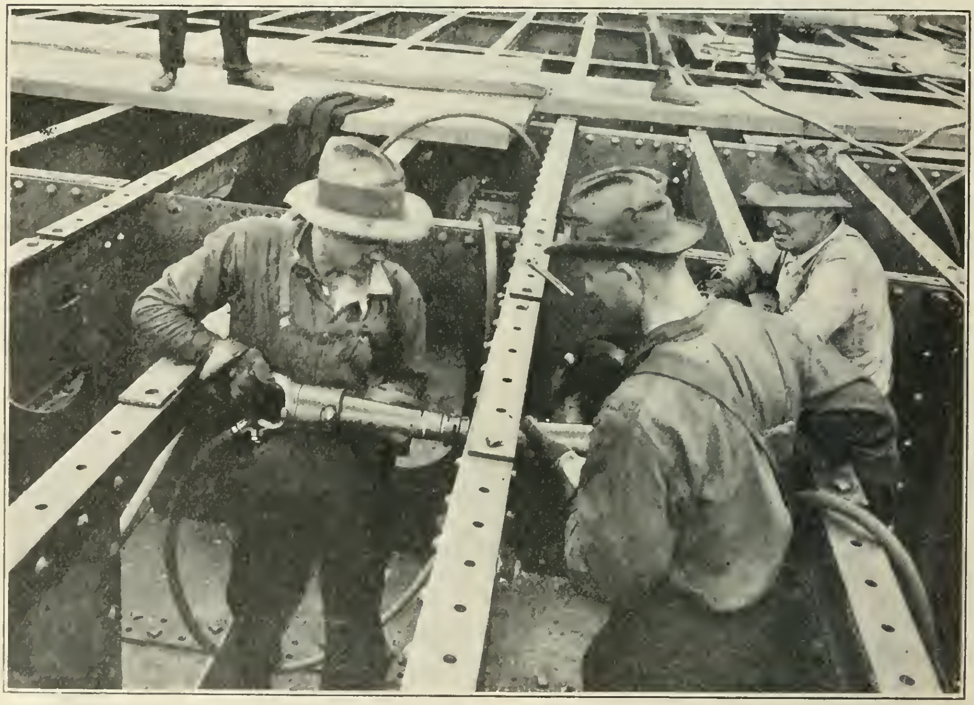


FIG. 2

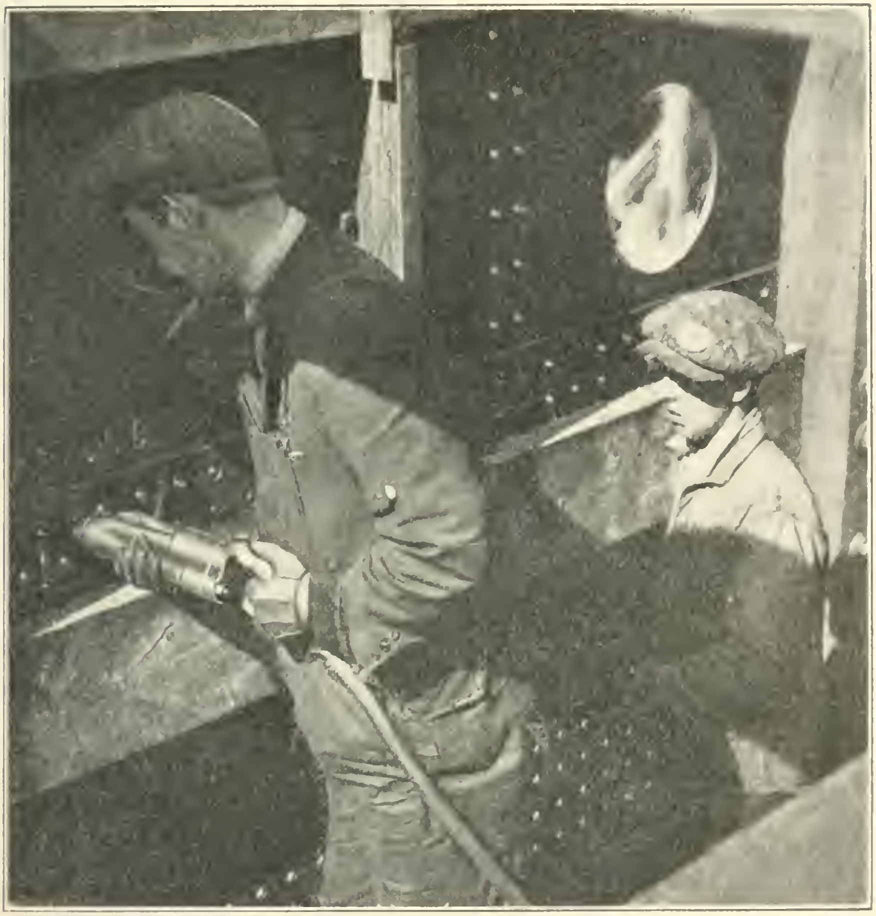


FIG. 3

carried into the machines tends to wash away the lubricant and to increase the wear by leaving bare rubbing surfaces in contact. It also condenses and collects in the pipe lines, interfering with the free passage of the air, and may freeze and choke the pipes in cold weather. This disadvantage is particularly serious when the work is in the open.

To eliminate it each of the compressors has been equipped with an after cooler and separator which serves to remove the moisture from the air before it enters the distribution system. This is accomplished by cooling the air to a point at which the moisture will condense and accumulate in suitable receptacles to be drained at intervals. The after-coolers serving the two large compressors in each plant along the ways have a cooling surface of approximately 1005 square feet, and the one serving the smaller compressor 505 feet.

Intake air is drawn from the outside through cast iron or salt-glazed pipe cast in the concrete foundations and terminating in sheet metal cowls 12 or 13 feet above the ground. A suitable piping system is installed for leading the discharge air from the compressors to a receiver which acts as a separator and serves to dampen pulsations for the complete unit. Cooling water for the compressor jackets, inter-coolers and after-coolers, is supplied by a system of water pipes which later discharge the water into the Delaware river, along which the yard is located.

Indicating and recording thermometers and pressure gages are installed in the pipes. An air-flow meter is also to be installed in the 12-

inch discharge line leading from each compressor plant, between the receiver and the 10-inch air main.

The two plants which feed into the 6-inch main at the head of the wet basins are similar to the others except they contain only two of the smaller compressors, making the total capacity of each plant 4,550 cubic feet of air per minute. This makes the entire compressor capacity of the yard 73,675 cubic feet per minute. Maintenance of the compressors is facilitated by a 10-ton, hand-operated traveling crane. For storage and operating maintenance of the air tools used on the ways, an air tool house has been built at the head of each group of five building slips. These buildings are equipped with grinding and lubricating machinery and storage racks.

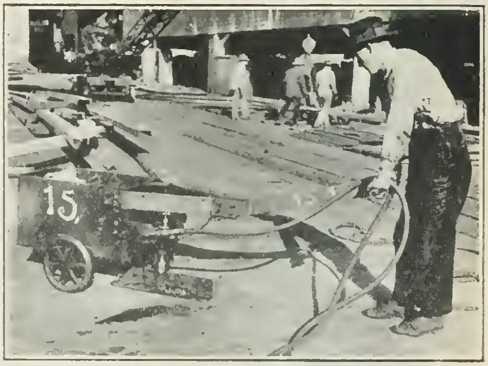
GREAT NUMBER OF TOOLS USED

An idea of the volume of compressed air required in building the ships may be obtained from the following list of pneumatic tools in use: 1675 riveters of one size and 100 of another; 1325 holders-on; 200 jam riveters of one size and 480 of another; 450 nonreversing pneumatic drills; 200 corner drills; 150 breast drills; 100 chipping and caulking hammers of one size and 1250 and 500 of other sizes respectively; and 50 grinders. Eight hundred rivet heating forges are to operate from compressed air lines. Equipment necessary to the operation of the pneumatic tools includes about 300,000 feet of rubber hose, 6500 sets of pneumatic hose couplings, 150 bottom riveter frames, 12,000 chisel blanks and 15,000 rivet sets.—*Marine Review.*

PORTABLE MOUNTING FOR PNEUMATIC DRILL

By H. H. Hicks

The accompanying illustrations show how a "Little David" drill, No. 1-B, has been rigged up by the Hanlon Drydock and Shipbuilding Company, Oakland, California, for service as a portable countersinking machine. The drill has been fastened to two metal supports bolted to the sides of an iron box 16 inches wide, 24 inches long and 16 inches high, provided with a suitable stop for the feed screw. The rig is fitted with a 6-foot handle and mounted on two wheels. Sufficient weight is placed on the box to give the outfit proper stability when in operation. An air hose is connected and a valve placed in the line for use instead of the usual drill throttle. A second hose is provided to feed water for cooling the countersink. Mr. Hiefield, the superintendent, is authority for the statement that this rig will do from 75 to 100 percent. more work than the stationary wall countersinkers.



PORTABLE MOUNTING FOR LITTLE DAVID

An outfit of this kind can be easily constructed in any shop and represents but a moderate investment. A suggested modification is that the box be partitioned through the center and that counterweights be carried in the compartment farthest from the drill; and the other half of the box be used as a tank to carry water for cooling the countersink. This would obviate the necessity of double hose connections.

EFFECTIVENESS OF MUSTARD GAS SHELL

The recent announcement that the Allies now have an effective supply of mustard gas shell shows how vital the chemist's work is to modern warfare. The gas shell has been one of the biggest problems for the American chemist, especially for those connected with the Chemical Warfare Service of the National Army. That the problem has been well solved is attested by documents found on captured Germans during the great drive now in progress. These documents state: "This gas (mustard gas) seems to have, even in diluted form, more harmful effects than the gas contained up to the present time in shells used by the field artillery."

Mustard gas, now being used extensively by both the Central and Entente powers, is a compound chemically known as dichlorethyl sulfide. In trench language it is called "mustard" because of its strong pungent odor, and to the Germans it is officially known as Yellow Cross gas, as the shells are all marked with yellow crosses and bands. The Allied chemists have known the composition of this gas for some time, but only recently have they been able to perfect a process for manufacturing it on a large scale. Fortunately for our armies, this method is far superior to methods known hitherto.

Although the effects from this gas are not often deadly, still it is a very effective agent on account of its slow and insidious method of poisoning. The odor of mustard indicates danger, but is not in itself uncomfortable until it causes the nose and throat to become irritated. If properly protected, there will be no further bad effects. In extreme cases the eyes and lids become inflamed and blistered and severe inflammation in the lungs results in bronchitis and even pneumonia. The after-effects of the poisoning lays one up for several weeks, but seldom results in death.

The most disagreeable thing about the gas is its persistence, which necessitates keeping on gas masks for hours at a time. It lingers in dugouts for days, and has to be forced out by means of fires and fans. In this connection, the captured German documents state, "gas poisoning still occurred among those who took off their masks after wearing them for 12 hours."

HIGH FLYING EXPERIENCES

By Captain B. C. Hucks

The most marked development in the modern machine is its extraordinary capacity for climbing to a great height in a short time. At the beginning of the war the average height flown on active service was 4,000-5,000 feet, simply because few of the machines then in use with the impediments carried could get much higher. Today a height of 20,000 feet is, I believe, on certain occasions reached, and it is fairly certain that if progress continues at its present rate, heights a great deal beyond this figure will be reached as a usual thing. These great altitudes bring forward many difficulties which will have to be seriously considered. The first trouble in the winter will be the extreme cold to which the occupants will be subjected unless they are protected by special cowling. This, to a certain extent, is the natural advantage obtained in the tractor. The question of the difference in the comfort of machines in this respect was shown to me in a very marked manner last winter. I was testing the fall-off of engine power at a height on a tractor two-seater in which it was specially arranged that the warm air from the radiator and engine passed along the fuselage to the pilot and then to the passenger, and although at a height of over 21,000 feet with the thermometer below freezing at ground level, I did not suffer in the least from the cold, neither did my passenger who sat behind complain until we shut off to descend. As a contrast to this, a few days later I was on a single-seater scout at an altitude of 17,000 feet, and although it was a tractor with a rotary motor, I suffered intensely from the cold, and became so numbed that my vitality must have been something akin to a dormouse under the snow, and, in spite of being well gloved, I had frostbitten finger tips which pained for many days afterwards. Surely this is a very inefficient state for a pilot at the front to have to take on an air fight or other exacting work? Put two pilots up to a great altitude, one kept well warmed and comfortable, the other half dead with the cold and it would be easy to surmise which would be most likely to do the best work.

I really believe it is more by accident than design that the pilot or passenger has benefited at all in the past from the heat of the engine, with the exception perhaps of the late S. F. Cody's machine. He purposely placed the radiator of his pusher in front of the pilot to keep him warm. I know from my experience when flying in France in the cold weather that the discomfort owing to the extreme cold became intense when flying only at 6,000 feet on a two or three hours' reconnaissance flight. This is a point to which designers should give attention, as machines are now capable of reaching great heights.

Cold also affects the motor pretty seriously. This is more noticeable with the water-cooled type. Unless some provision is made for blanketing the radiator surface at heights, it becomes far too cold for efficient running. Cases are known of the freezing of the water system on a descent from a great height, with pretty serious results to the motor, as well as the difficulty of getting the engine to run again efficiently through being too cold to effect a landing. In the future war machine the pilot must have a very wide range of control over the water-cooling system.

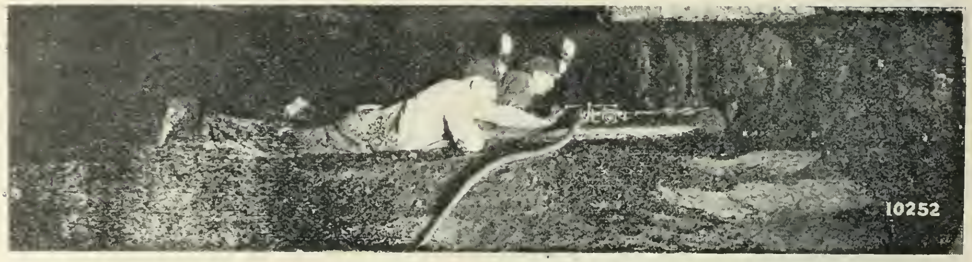


FIG. 1

MECHANICAL EQUIPMENT AND THE CONSERVATION OF MINERS

By R. L. Herrick, E. M.

Mine-labor shortage is in these days the bugaboo of the anthracite district. Recent drafts to the army have aggravated an already bad labor condition. Before the draft many mines were running with mine crews depleted from 15 to 40 per cent. from those of normal pre-war times, and now the production of anthracite threatens to ebb to a new low mark. The mining situation presents a curious discrepancy, however, that may well be noted. It is this: While the loss of many men has adversely affected the production of some of the largest and oldest mines of the district, others with similarly reduced mining crews have actually increased their tonnage. Investigation into the causes of this discrepancy has led to the conclusion that the gain or loss of tonnage is largely a question of mechanical equipment. Those mines which have held their tonnage output to about normal—or if anything have increased it—have installed modern machinery equipment which has conserved the man-power of the organization. Instances are common where the installation of certain machines has made what was formerly heavy labor now easy on the men, and at the same time allowed one or two of them to do the work formerly requiring the united efforts of from six to eight. It is, of course, understood that the men thus released from routine work have been immediately transferred to the vitally important work of getting out coal.

In what follows it is proposed to give typical examples of such man-power saving as were observed in the course of a 450 mile automobile trip about the mines in various parts of the anthracite district. An engineer intimately acquainted with the district through long residence, Mr. William Wilhelm, Scranton manager of the Ingersoll-Rand Company, is sufficient authority for the accuracy of the statements here made.

To what extent will it pay to replace hand with machine drilling? The anthracite operator is squarely face to face with this issue today. And upon his answer to that question largely depends the amount of man-power conservation he will be able to effect. In general terms it may be stated that coal is ordinarily machine-drilled in say from one-fifth to one-sixth the time that the same holes can be put in by hand. The hardness, dampness and physical properties of the coal vary widely in different parts of the anthracite district, and all of these conditions affect the speed of drilling. Thus in some sections the hand drilling of a 6-ft. hole requires say 10 min., while in others it cannot be done in less than 30 min. In general, therefore, the same holes will require only say 2 to 6 min. when drilled by machine.

On the face of the situation thus presented

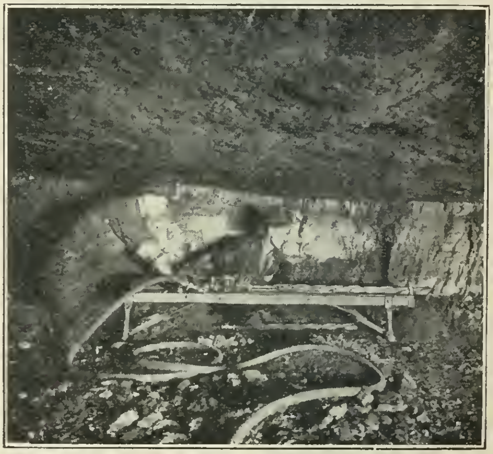


FIG. 2

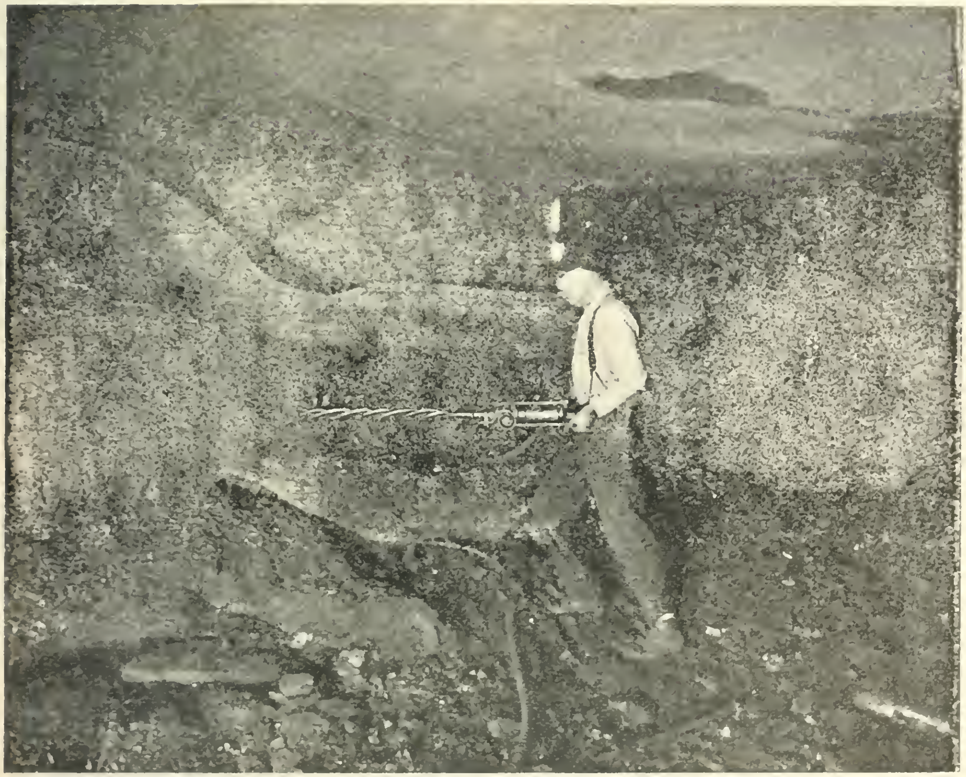


FIG. 3

there could be no question about the advisability of universally adopting machine drilling. But actually there are a number of other considerations which influence the operator. Perhaps one of the elements most vitally affecting the problem is the fact that in most of the large operations the miner is practically a free agent He is paid by the ton of coal, or yard of advance in rock, and his hours of work are advised, but not dictated, by the mining companies. In addition to this, the miner owns his own tools, although he may be financed by the operator to enable their purchase.

Under such conditions it is only natural to expect that machine drilling of coal is in vogue only where the mining conditions themselves caused the miner to employ drills in order to make, what are to him, satisfactory wages without a great deal of unnecessary hard work and in a satisfactory number of hours of labor.

So far mining conditions have made immediately advisable the adoption of machine drilling only in thin beds of comparatively small pitch. War conditions such as high price, etc., have enabled the working of such beds at a profit. Hence, in thin measures we find machine drilling of coal naturally making its first big progress of supplanting hand drilling. This is not meant to imply that in thick beds progress with machine drills has not been large, but only that this progress has been comparatively greater in thin beds Some of the reasons for this condition are made plain by contrasting Figs. 1 and 2, showing thin-seam mining, with Figs. 3 and 4, which illustrate conditions in much thicker, beds of coal Fig. 1 shows the drilling of a bottom hole in an anthracite bed which is only 20 to 24 in. thick. In this case a plank is used on which the Jackhamer is slid along Fig. 2 shows another view in this same bed, using a JC-40 drill mounting. The bottom of this bed consists of 6-in of bone and is consequently exceedingly hard to drill.

Such beds as this were practically impossible certainly unprofitable, to mine with the old hand-auger drilling method, but have been made profitable with machine-drill methods which produce a good tonnage per day.

Fig. 3 shows the drilling of a horizontal hole in the Dunmore vein, which, as plainly shown, consists of alternating bands of coal, bone and slate, making up a total thickness of about 6 ft. Such a bed is hard to drill by hand, and hence the favor shown to machine drills.

An example will suffice to still further clarify the situation: A coal bed 30 in. thick is mined in the Scranton district by rooms 30 ft. wide. The coal face is attacked by say from 11 to 14 holes, drilled about 6 ft. deep, which should blast down 450 cu.ft. of material, netting say 16 tons of coal.

The hand-auger drilling of these holes will require an average of say 30 min. to the hole, thus requiring 6 or 7 hours of labor. The machine drilling of these holes will take only from 55 to 70 min. to complete, although these are by no means the quickest figures on record.

Figs. 1 to 3 all show the use of twisted cruciform steel in connection with the Jackhamers. These machines differ in no way from the standard drill striking a hammer blow, but the use of twisted steel allows the standard drill rotation to produce an auger-like effect in the holes, thus rapidly clearing them of pulverized coal (clearly shown in Figs. 1 and 2 beneath the steel).

The use of this cruciform steel has rapidly grown in favor, especially during the past year in the Scranton district. It was originally furnished by the manufacturer in sizes to accommodate the usual diameter of black powder cartridges. But in response to the demand for hand-drill outfits in other districts, where Monobel powder is in use, another size of twisted steel is being manufactured and will soon be available.

For the mining of thin coal beds the drill mounting shown in Fig. 2 has proved a boon to the miner. In fact its lightness enables quick movement from place to place, while its operating features reduce the miner's drilling job to a sinecure. He has only to push the drill straight ahead, and it practically runs itself.

Aside from being easier than hand-holding upon the drill operator, the mounting performs the double function of providing a steadyrest in starting and pointing the hole, and that of furnishing a support during the drilling. Without such a support the average miner lets the drill practically hang upon the drill steel after the latter has advanced 6 or 8 in. into the coal. The support afforded by the mounting has been found to practically eliminate drill steel breakage arising from this cause.

While machine drilling of coal is apparently most common in the thin beds, and in those thick ones whose bone and slate layers make hard hand drilling, it has a great future in the thick and easily hand-drilled seams. War-time conditions seem certain to hasten the coming of that future.

The visitor to the various mines of the anthracite district is somewhat puzzled to account for the facts as he sees them. For instance, in many thick and easily mined beds he finds the Jackhamer busy, as shown in Fig. 4 taking up the rock bottom. For rockwork nearly every mine in the district has such machines by the score. But when it comes time to mine the coal, the miner picks up his hand auger and goes at it. This may not be the rule but the writer saw it often enough throughout this district to be impressed by its frequency.

For example, in the case of the mine shown by Fig. 4 the coal bed was 8 ft. thick, had a high pitch, and the coal itself was comparatively soft. The miner could drill his 8-ft. holes in about 10 min. each by hand auger, and could completely drill his room in about two hours. Under the present working conditions he could bring down in a few hours all the coal by hand that his one "buddy" could load in a day. Those few hours enabled him to quit about noon well satisfied with his usual day's wages.

This particular miner was not interested in the machine drilling of coal, and for obvious reasons. This illustrates the perplexing problem some mine operators face today. The present situation may, in fact, be paraphrased as this: "One miner, one auger and one buddy." Why should it not be: "One miner, one machine drill and four buddies?"

Is there any reason why the miner should not acquire greater dignity as the employer of four helpers instead of one, and make increased mining profits in proportion? Must the correction of a decreasing coal production be impeded by the old-established custom of

FIG. 4

having one buddy only? Upon the answer to these questions may hang the fate of nations!

Suffice it to say that it is believed that under changed conditions a machine-drill miner can easily replace four hand-auger men in thick beds and thereby allow the saving of three miners, thus made available for either increasing the coal output or filling the gaps in the ranks of the buddies drafted into the army. Fifty hand-machine drills installed in a mine should result in a man-power conservation equivalent to 150 miners per day.

Many of the coal-mining companies of the anthracite district have greatly increased the number of hand-machine drills employed underground during the past year. As a result, an increased burden of steel sharpening has been thrown upon the blacksmith shop.

The sharpening of hollow drill steel by hand is a comparatively slow and unsatisfactory method. In the average shop a blacksmith and helper will hand-sharpen about 35 to 40 seven-eighth-inch hexagon steels per day, depending upon their condition. And since the blacksmith must rely solely upon his eye for gaging, he usually makes a gage interval of about ¼ in. between successive steels of a drill set in order to insure against sticking. This handwork is so slow that frequently defects develop in the bit due to its cooling before it is properly shaped.

With the increased demands upon the blacksmith shop for steel sharpening, many mining companies started the installation of Leyner machine sharpeners. These have proved one of the most pronounced labor savers introduced into the district. An installation of one of these sharpeners in one of the largest shops of the Scranton region is shown by Fig. 5.

In this shop there were four forges employing four blacksmiths and four helpers.

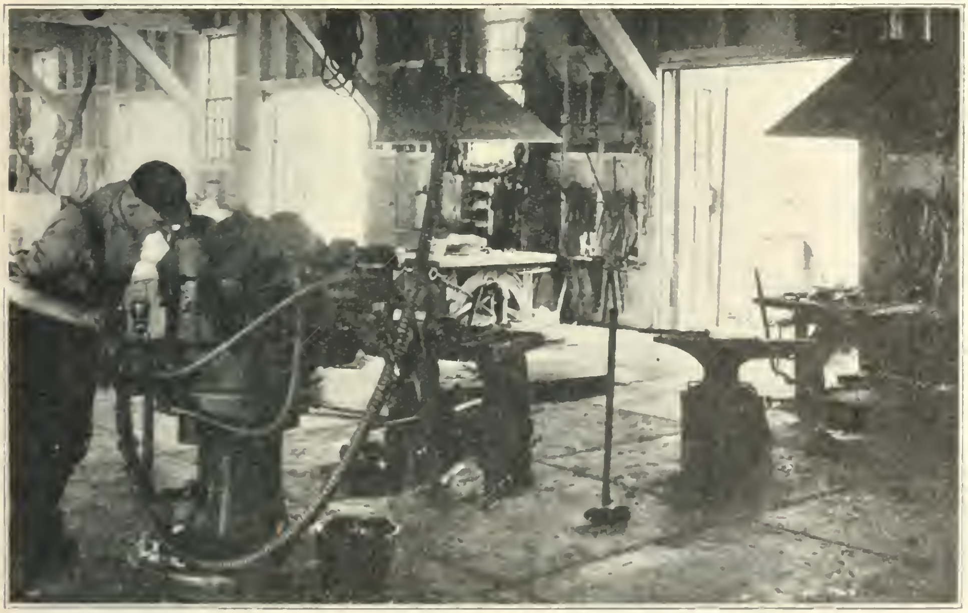


FIG. 5

The operator of this machine did all the steel sharpening of the eight men and turned out a large amount of routine blacksmith work in addition. The seven men thus made available were badly needed at other work about the mine and were so utilized.

Aside from this labor-saving feature of the machine sharpener the bits themselves are far superior to the hand-made ones. Owing to the perfection of bits, made inevitable by the machine's gaging, it was possible to reduce the gage interval between steels to 1-16 in. instead of the ¼ in. as formerly. This results in greater drilling speed in the mine.

This machine sharpener is equipped for making the shanks on 1⅞-in. twisted cruciform steel. Besides its common work of shanking and sharpening steels, it is admirably adapted to blacksmith work of many kinds, such as making boltheads, and even drawheads for coupling mine cars. Some of the mines have fitted up these sharpeners with dies for making mine-car couplings, which work is being done with great rapidity.

In many sections of the anthracite district, particularly where the coal beds are of steep pitch, the movement of mine timbers into the upper workings presents a real problem. In such places the Little Tugger hoist serves a double purpose—that of supplying the needed tractive power and furnishing air for ventilation.

In one section of the Catherine colliery of the Trevorton Coal Co., the Lykens No. 2 vein pitches 15½ deg. and the steady movement of timbers up such a steep slope taxed the endurance of the men formerly employed on the job. A slope 250 ft. long connected two levels. Up this the timber was moved, and down it was discharged the coal extracted in the development of the upper level.

The development of four rooms and two gangways required six mine-car loads of timbers per day, and for carrying up the timbers by hand six men were formerly employed constantly.

A Little Tugger hoist was recently installed in close quarters at the head of the sheet-iron-lined timber chute. Its 5-16-in wire rope is pulled down into the lower level, where one man attaches it to the timbers on the cars. On signal, the hoist then pulls up from three to four timbers 14 ft. long and averaging 8 to 10 in. in diameter. The ropeman rides the timbers to the upper level and returns with the slacked-off rope.

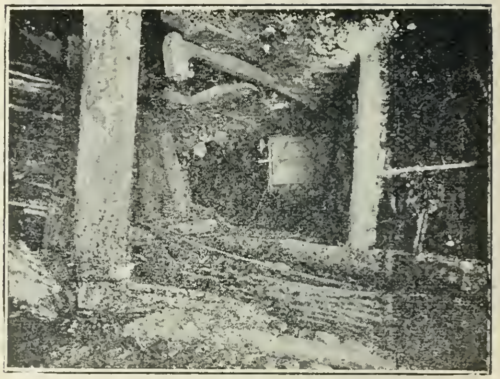


FIG. 6

The timber is thus hoisted with only one man in addition to the hoist operator. These two men thus accomplish, in one-half day, the work formerly requiring six men all day. The other four men are accordingly available where badly needed for getting out coal. The hoist, therefore, performs the equivalent of eight men's work per day.

The hoist has a speed of 85 ft. per min. in lifting a maximum weight of 1000 lb. vertically, but in hauling these heavy timbers 250 ft. up the slope, about 5 to 6 min. are required for the round trip by the ropeman.

When not in use for timber hauling, this machine is available for hauling coal in a one-ton buggy from the face of the level along a slight grade, to the rocker dump at the head of the chute. Fig. 6 shows the loaded buggy approaching this discharge point.

Scores of these hoists have already been installed in many mines of the anthracite district. They are used for a wide variety of purposes, such as, for instance, the hoisting of rock in buckets from shallow shafts, the hoisting of tools and men into raises, and even pulling 40-ton capacity empty coal cars up a slight grade to a loading position beneath the discharge chutes of a breaker.

At another large colliery an unusual installation of these machines shows their strength as well as adaptability. In driving a rock tunnel to connect with a shaft, it was desired to use the 108-cu.ft. capacity cars, standard about the mine, to receive the rock mucked from the face. The rock tunnel connection was about

FIG. 7

300 ft. long and had only a slight grade except at one point where for about 50 ft. the track was given a grade of 10 per cent.

The 108-cu.ft. car loaded with rock weighs about 12,000 lb., and to pull it up the 10 per cent. grade three hoists were installed, as shown in Fig. 11.

The concentration of three separate hoists pulling three ropes attached to one heavy car is, of course, rather unusual and would not often happen except in emergency cases, and then only for temporary work. This installation serves to forcibly illustrate, however, the wide adaptability of these machines, and the possibility of tiding over, with them, a situation where the delivery of a powerful single hoist under present conditions would seriously delay urgently needed mine development.

Large numbers of these little hoists are employed in the anthracite district. In each case the machine does the work formerly requiring from six to eight men. Assuming, however, that each one effects a man-power conservation of at least four men, twenty such machines effect a conservation of at least eighty men. There are a number of companies throughout the district which have installed as many machines or even more.

Activated sludge, when air-dried, is a dark brown, friable, inoffensive material with a slightly earthy odor like that of decayed leaves. It consists largely of humus, but contains much more nitrogen, phosphoric acid and potash than does ordinary farmyard manure.

THE BEST OILS FOR AIR CYLINDERS

By W. H. Callan

A number of years ago, when the compressor business was young, considerable trouble was experienced in procuring a suitable oil for lubricating the air cylinders of compressors. After considering the matter for some time, it was decided by the company by which I was employed that an expert on the subject should be consulted. Accordingly, the matter was taken up with a well-known oil company, whose representative called upon us and, after making a careful examination of the conditions, reported that the trouble was entirely due to using an oil of too light body and too low viscosity to withstand the high heat of the compression. He stated that the oil used was gassified, due to the high temperature of the air, and that it passed off in vapor, leaving the cylinder wall without lubrication. The expert thereupon recommended an oil which he considered suitable for our use. The particular grade happened to be of 26 Beaumé gravity with a flash point of 515 deg. F., a fire test of 555 deg. F., and a viscosity of 130 S at 212 deg. F.

NO INCREASED EFFICIENCY WAS SECURED

After using this oil for some time, we found no improvement in the operation of the machine; in fact, it appeared to be laboring and the temperature of the discharge air was high. After several days of operation with this new oil, the cylinder heads were removed, the valves taken out and a careful examination made. The cylinder wall seemed to have a sticky, plastic coating; the air passages and discharge cavity of the cylinder showed signs of dark deposits, while the faces of the valve seats were covered with a black, hard coating. This hard formation on one side of the valve seat caused the valves to leak, hence the increased temperature of the discharge air. The sticky coating on the wall of the cylinder was responsible for the increased friction.

The representative's attention was called to this condition, whereupon he suggested that a little lighter oil be used. This time he recommended one with 27½ Beaumé gravity, a flash point 450 deg. F., a burning point of 500 deg. F., and a viscosity of about 125 S at 212 deg. F. We asked him if he did not think this was a little too heavy a grade for air-cylinder lubrication. He assured us it was not, and stated that, in order to withstand the high temperature of the compressed air, it was necessary to have a rather low gravity and high viscosity oil, with a flash point above the temperature of the air.

After we had used this grade of oil for some weeks, a further examination was made; and while the cylinder wall appeared considerably better, the valve passages and discharge cavities of the cylinder were badly coated with a hard deposit. When this matter was again brought to the attention of the expert, he suggested that we reduce the amount fed into the cylinder. This was done with great care until we were only using three drops a minute in a 14x14-in. cylinder running at 150 r.p.m. But even under these conditions the deposits in the valve passages and the discharge cavities of the cylinder continued to form as long as this oil was employed.

The expert happened to come our way several months afterward, and I called his attention to the condition experienced with his oil. In regard to the amount we were feeding into this cylinder, he said this was reduced to a point that he thought was the minimum. His reason given for the formation in the passages was that the residuum of all oils is carbon, and that it therefore was no doubt due to carbon deposits. At the same time he assured us that the oil he had recommended was the best procurable for the purpose, and that we should go ahead and use it without any fear.

DEPOSIT BUILT UP RAPIDLY

This was done, but the formation in the discharge passages seemed to be building up rapidly despite the fact that only a small quantity of oil was being fed into the cylinder. These formations finally collected to such an extent that it was necessary to clean the passages in order to avoid the hazard of an explosion. The passages were accordingly cleaned, and some of the material removed was analyzed and found to contain about 1.5 per cent. free oil, 11 per cent. rust, 5 per cent. decomposed oil, 30 per cent. mineral ash, 10 per cent. coal dust, while the remainder was foreign matter, or residuum. A further investigation revealed the fact that our intake was exposed to such material as coal dust, mineral ash, shavings, water, etc., as well as some air.

After cleaning the compressor, and safeguarding the intake against dirt and dust, we procured another grade of oil which in our own judgment was more suitable for the work since in the meantime we had made investigations and studied the question to some extent. This time we procured an oil of 31 Beaumé gravity, a flash point 375 deg. F., a burning point 420 deg. F., and a viscosity of 200 S at 100 deg. F. We started by feeding three drops per minute. Finding the cylinder copiously oiled, we reduced the feed to two drops a minute. The compressor was operated in this condition for a considerable length of time with practically no trouble from carbon deposits.

Experiencing such good results from this light oil, and by this time disbelieving in many of the virtues claimed for low gravity, high flash point and heavy viscosity, we were prompted to try another grade of oil, selecting this time one having a gravity of 33 Beaumé, a flash point of 380 deg. F., a fire test of 420 deg. F., with a viscosity of 140 S at 100 deg. F. We used the same quantity as before—namely, two drops per minute in a 14x14-in. cylinder running 150 r. p.m. This oil was used for years without any trouble from lubrication, valve leakage or carbon deposits.

The oil representative made his regular calls on us, and each time we told him what we were doing; but he assured us we were on the wrong track and that sooner or later would get into trouble. After continued tests, however, and careful observation of all conditions, we became satisfied that the latter oil is the most suitable for air-cylinder lubrication when working against a 100-lb. pressure, with either single- or two-stage compression.

AN OLD FRIEND CALLS

One day an old friend of mine called, who also happened to be an expert representing one of the leading oil companies. I related to him my experience with air-cylinder lubrication and, somewhat to my surprise, he too assured me that we were using the wrong oil and said, "You know you get not less than 400 deg. C. F. in your air cylinder when working against 100 lb., single stage." With this I agreed. I then asked him how he knew we were wrong, and what means he employed for ascertaining the proper grade of oil for air-cylinder lubrication. He then proceeded to explain the method his company's engineers use in determining the proper oil for different kinds of service.

He explained this in part:

"You have agreed that the temperature of the air is 400 deg. Our test would be conducted as follows: Take a block of cast iron 6 or 8 in. square and 2 in. thick, place this block on a layer of sand in a shallow iron pan and pack the sand closely around the cast-iron block, then put a gas burner under the pan and turn on the heat slowly. The top surface of this block is polished and is provided with a drilled hole into which a thermometer is inserted. Heavy steam-cylinder oil is poured into the hole around the thermometer bulb so as to make a close heat contact. When the thermometer rises to 400 deg., lower your gas burner until the thermometer remains steady at this temperature. Then take your different samples, dip the point of a lead pencil into the oil, hold the pencil 2 in. from the surface of this iron block and allow a drop to fall on the hot polished surface.

When such a test is made with the grade of oil from which you say you are getting successful results, we find the drop spreads out to about 1⅛ in. in diameter, smokes a little, dries up, and is evaporated in ten seconds time, leaving the surface perfectly dry. With a higher grade of oil having a flash point of 450 deg. F. and heavy viscosity, when the drop falls on the surface of this polished block it spreads out to about 1¼ in. in diameter, smokes a little, but after five minutes the surface is still oily. Thus we have proof that this is the proper oil to withstand such service as you get in your air-compressor cylinder.

Then I asked him what he thought the temperature of the surface of the cylinder wall was when the air in the cylinder was at 400 deg. F. He hesitated a little, then said he believed it would be about 25 deg. F. less than the temperature of the air. I disagreed with him here, saying this did not seem right, as the water-jacketed wall should be much cooler than the air. After some discussion we went into the office and consulted some authorities on the subject; we found some tests had been made abroad on the temperature of the cylinder walls in an internal combustion engine, where, with an explosion temperature of 2700 deg. F. and an average temperature through the cycle of 950 deg. F., and the water in the jacket at 200 deg. F., the inside surface of the cylinder wall did not go above 267 deg. F.

When my friend was shown these figures he was nearly speechless, and admitted that he had never thought that the temperature of the wall of an internal combustion engine cylinder, with an explosion temperature so high, could remain as cool as this authority stated. However, since the character of the authority was such that it could not be questioned, it was accepted by the oil expert. I then asked what he thought the temperature of the air cylinder wall should be when the air does not exceed 400 deg. F., in answer to which he said he did not know, but did not believe it would be much above the temperature of the water in the jacket.

As a matter of fact, the temperature of the inside of a water-jacketed cylinder wall is not more than 30 deg. F. higher than the temperature of the jacket water, as long as the water does not boil; and, since this is the true condition, what is the use in employing oils of low gravity, high fire test and high viscosity to meet a condition such as this? The temperature of the inside surface of the cylinder wall on an air compressor is little, if any, above the temperature of the surface in the main bearing of the ordinary Corliss engine.

HIGH VISCOSITY IS NOT ESSENTIAL.

From this it appears that the ordinary oil expert who lays much stress on high viscosity and high flash point has not considered the true conditions. Furthermore, it has been shown in this article that the cause of carbon deposits in the passages of an air cylinder is not always entirely chargeable to the residuum of oil, but in many instances is due to using a lubricant of too heavy a body, which adheres to the passages of the cylinder. Also, when the inlet is not properly protected from foreign matter, all such material as coal dust, fine ashes, shavings, waste, etc., is drawn into the cylinder and deposited on the sticky surfaces coated with this heavy oil. This foreign matter, with additional oil, gradually builds up until the passages become choked. The air valves now begin to leak for some reason, thus increasing the temperature, until finally this sometimes reaches a point as high as 500 deg. F. when compressing to 100 lb. single stage. If there are many shavings or much coal dust deposited in the passages, this is apt to char and become incandescent. When this takes place the temperature of the air rises rapidly, and as a consequence the pressure increases quickly to a point beyond the strength of the receiver, and results in what is generally called an explosion.

It is my opinion that no violent explosion ever takes place in the ordinary air compressor, unless kerosene, gasoline or some such material is introduced into the compression.

In my personal experience some years ago with a two-stage compressor where the intake had been neglected and also the wrong grade and quantity of oil had been used, the high-pressure discharge valves became leaky, thus allowing the air to churn in and out of the cylinder at each stroke, and heating it until it became so hot that the heavy deposits in the passages actually took fire; the whole system burned out, like a chimney from an old-time wood stove. Fortunately, however, there was no explosion because the safety valve on the receiver relieved the sudden pressure caused by the burning material in the discharge passages and the compressor was promptly shut down.

From the foregoing it will be understood that in the selection of an oil for air-cylinder lubrication, nothing should be used but a pure mineral product having a gravity of from 31 to 33 Beaumé, a flash point of 375 to 390 deg. F., and a viscosity of 140 to 150 S at 100 deg. F. Under no circumstances should a heavy grade be used, despite whatever claims may be made by the oil salesmen as to the virtues of heavy viscosities or high flash points. It should also be borne in mind that when the surface of the cylinder wall is once glazed over, little oil is required to properly and adequately lubricate the working surfaces.

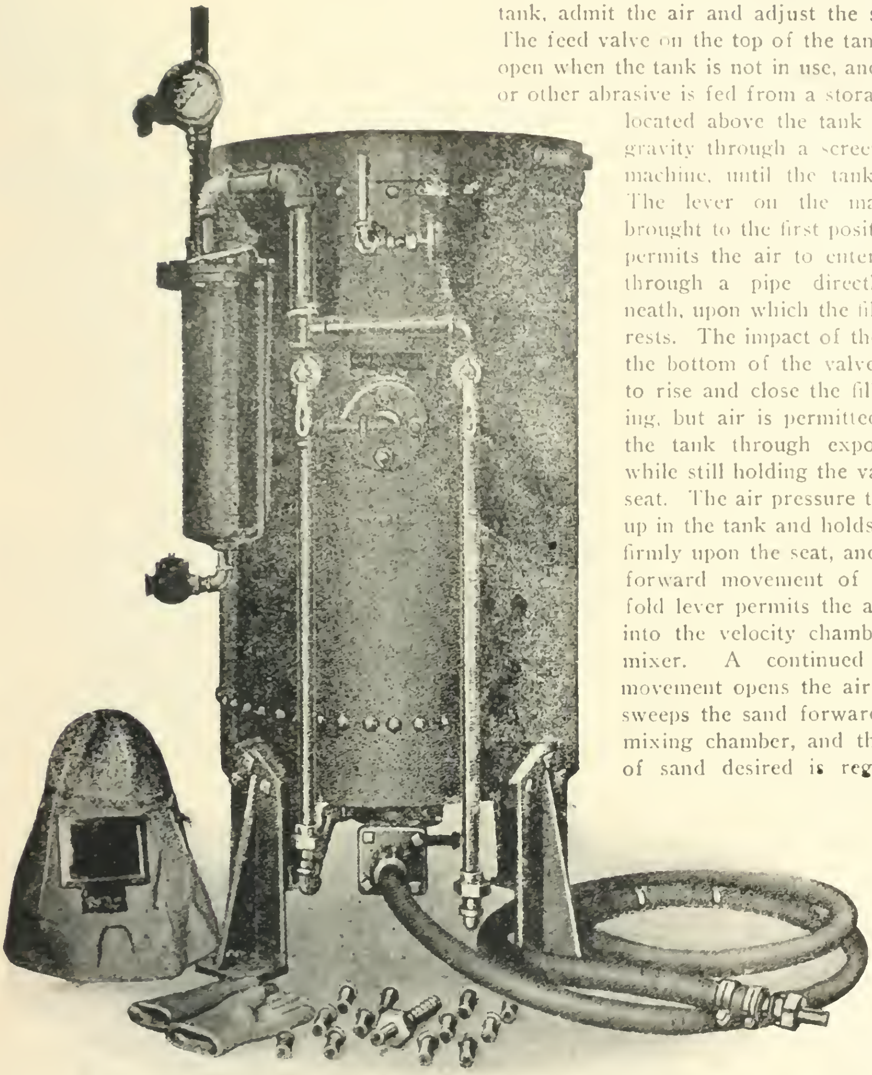
TOO MUCH OIL FORMS CARBON DEPOSIT

The film of oil on the cylinder wall is understood to be less than 0.00025 in. in thickness. The piston rides back and forth on this film, which requires little oil to be added in order to maintain the necessary quantity. Should a greater amount of oil be used than just enough to keep up the required film, it will be plowed up ahead of the piston and be forced through the valves and into the cylinder cavities, where it will collect in the low places and solidify by reason of being mixed with foreign matter taken in through the inlet. This forms deposits commonly called carbon.

As has been shown, a 14x14-in. cylinder can be adequately lubricated with two drops of oil per minute when the compressor is operated at 150 r.p.m. This is the equivalent of one drop of oil for each 800 sq. ft. of cylinder surface swept by the piston. The oil herein referred to happened to be made from a paraffin base petroleum. However, it is believed that an oil of about the same consistency, refined from an asphalt base natural oil would serve as well, if not better.—*Coal Age.*

AUTOMATIC POSITIVE PRESSURE SAND BLAST APPARATUS

The illustration herewith shows the essential features of the positive pressure sand blast apparatus made by The W. W. Sly Manufacturing Company, Cleveland, Ohio. With an unfailing supply of sand and of air the continuous operation of the machine is automatically provided for. The body of the machine is a sand tank with the mixing chamber under the lower head. This mixing chamber has a plate upon which the sand is fed from the tank by passing through an inverted taper sleeve, this sleeve being relied upon to prevent any obstruction from entering the mixing chamber which would not subsequently pass through the lip of the hose. The sand discharged by the feed sleeve upon the sand plate is wiped forward by air from an adjustable air port and by this means the flow of sand is controlled. The air passing this port is divided by a deflector so that the walls, which otherwise would be subjected to the action of the sand, may be protected by a bank of clean air, the sand being nibbled away by that portion of the air that is thrown forward toward the center. The velocity of the air passing over



the plate is only sufficient to wipe the proper amount of sand foward to a point just below the entrance to the hose, where it is picked up and shot forward by the high velocity air. This arrangement eliminates wear in the mixing chamber.

The operation of the tank is controlled by a specially designed manifold valve located on the side of the machine in a convenient position for the operator. The valve has only one lever and one progressive movement, forward and reverse, but this is sufficient to fill the tank, admit the air and adjust the sand feed. The feed valve on the top of the tank remains open when the tank is not in use, and the sand or other abrasive is fed from a storage hopper located above the tank falling by gravity through a screen into the machine, until the tank is filled. The lever on the manifold is brought to the first position which permits the air to enter the tank through a pipe directly underneath, upon which the filling valve rests. The impact of the air upon the bottom of the valve causes it to rise and close the filling opening, but air is permitted to enter the tank through exposed ports while still holding the valve on its seat. The air pressure then builds up in the tank and holds the valve firmly upon the seat, and the next forward movement of the manifold lever permits the air to flow into the velocity chamber of the mixer. A continued forward movement opens the air port and sweeps the sand forward into the mixing chamber, and the amount of sand desired is regulated by the progressive forward movement of the lever. The volume of blasting air remains constant while the valve lever is being moved. If the sand flow becomes impeded for any reason, a forward movement of the valve lever beyond the point of maximum sand supply to the hose and nozzle releases the air in the tank and reverses the flow up through the bottom. This is relied upon to break down any bank or remove the obstruction from the top of the feed sleeve, thus permitting the operator to continue work until the sand in the tank has become exhausted.

The machine is made in various sizes and generally mounted on four substantial legs as shown. It may also be mounted on a truck when it is desirable to use the machine at different points. A hose and nozzle of the best material is furnished, also sand blast helmet and pair of gloves as shown. There is a removable wire screen for the sand before charging the tank. A feature which should not be overlooked is the filter through which the air passes before entering the tank, the moisture being separated by centrifugal action. The pipe connecting with the compressed air supply projects vertically from the top.

HYDRAULIC RAM SHOWS HIGH EFFICIENCY

The Maple Leaf pumping station of the City of Seattle represents a new departure in the common practice for the construction of water-power pumping stations. This plant should be of interest to engineers, since it is believed that it develops perhaps the highest known combined power and pumping efficiency of any existing plant of like size or larger, and in addition shows unusual economy in installation and operating costs. It consists of two 12-inch Hill hydraulic rams operating under a 50-foot power head and against a pumping lift of 140 feet from a point above the rams to the full tank level. Performance tests showed a range of capacity of water pumped from 720,000 to 1,300,000 gallons per day with corresponding efficiencies of from 90.8 per cent. to about 85 per cent. The normal daily operating capacity is something over 1,000,000 gallons of water pumped.

Eventually the plant capacity will take care of some 28,000 population and furnish ample fire protection for the 790 acres involved. The rams are simple in operation. They are started with an auxiliary starting valve, and adjustment for capacity is made by turning an adjusting screw up or down. All mechanical movement is limited to simple valve shifts of small motion, and as all moving parts are inside the machines, in water, no oil is used or required. The rams operate continuously in the locked gate house and inspection is made only once or twice a week by the regular water department employee. Maintenance and renewals, limited largely to new valve seats, are estimated to cost not to exceed $10 per year per ram. As wear is exceedingly light, the rams maintain their full efficiency for long periods.—*Engineering News-Record.*

TOO LONG AND TOO WIDE FOR THE LOCKS, BUT SHE MUST GO THROUGH

When the United States entered the war 190 vessels on the Great Lakes were taken over by the Government and most of them have been taken to tidewater and put into the carrying of munitions and supplies. A large number of these vessels too long to pass the locks of the Welland Canal were cut in two and after reaching Montreal or Quebec were welded together again as good as new and at once put in service.

One ship, however, the Van Hise, a 9000 ton dead weight carrier, was not only too long but was also 50 ft. wide, while the extreme width limit of the locks to be passed is only 44 ft. Such a little thing as that, however, is simple enough to the modern engineer. It was found that when the deck was cleared of all superstructure the distance from deck to keel was only 25 ft. So the only thing necessary to do after the ship was cut in two was to place each half on her beam ends and run her through in that position, and that at the present writing is being done. A pontoon is provided to lie along under the side of the keel and the trim of the floating body is then easily adjusted by controlling the volume of air and water within the pontoon.

BONA FIDE RIVETING RECORDS

The following from *Emergency Fleet News,* a publication more or less official, may be accepted without question. The figures given are very different from some which have been circulated in the daily papers.

"Believing that everlasting team work is the most result-producing in the long run, Edw. G. McCulloch, superintendent of the Newport News Shipbuilding & Drydock Company, is trying to encourage riveters in that company's yards to drive an average of 400 'pegs' a day, considering that a fair day's work.

"In carrying out the idea a blackboard has been erected in the yard, upon which are chalked daily, statistics showing exactly what the various gangs are doing. This board has columns for the number of gangs working, rivets driven, average per gang, average that should have been made, gangs out, and rivets lost by gangs out. All sizes of rivets and all kinds of work are taken into consideration by J. H. Lofland, assistant superintendent of hull construction, in placing 400 rivets as a first-class gang average for nine hours. For June 13 the blackboard stood as follows:"

It Will Take About 75,000 Rivets Every Working Day to Give to "Uncle Sam" the Ships We Are Expected to Build This Year.

See below what YOU are doing.

Date—	No. Gangs In	Rivets Driven	Average Per Gang	Avg. We Should Have	Gangs Out	Rivets Lost by Gangs Out
June 3rd	156	53,288	342	400	21	7.182
June 4th	154	50,492	328	400	31	10,168
June 5th	167	62,381	374	400	20	7,480
June 6th	168	55,477	330	400	17	5,610
June 7th	169	54,985	325	400	21	6,825
June 8th	146	32,301	442	400	38	16,796
		308.924				54,061

Saturday, June 8th, was half-holiday.

June 4th.	No. 16930, Powell	drove	1217	on	Hull	No.	225.
June 5th.	No. 16958, Crawford	"	1400	"	"	"	224.
June 6th.	No. 16893, Johnson	"	1541	"	"	"	225.
June 6th.	No. 16906, Poarch	"	1648	"	"	"	225.
June 10th.	No. 16873, Price	"	2100	"	"	"	224.

Experiments carried out in Germany show that the inner tube of pneumatic tires keeps its elasticity for a long time when lying in a solution of 10 per cent. glycerine and 1 per cent. soda in water.

LOCATING ENEMY GUNS IN FRANCE*

No wonder the French called their engineers "Genie," thinking of the "Arabian Nights" and the genie that came out of the vase and accomplished all those wonders. They are the perfection of mathematicians. They have figured out the influence of the earth on a shell traveling out of the cannon; how much father it will shoot north than south; how much the height of the moon deflects the shot, and what is called the ultimate error of the cannon shot is disappearing under their mathematics. If a commander cannot point a cannon within ten feet of the shot he is not counted a success.

Somebody asked me how they located the guns and whether by aeroplanes. I said, "Not alone. There are three ways of doing it—spot flashing, sound ranging, and then the aeroplane to check both up." The most uncanny thing is sound ranging; it is shooting around the corner, surely. They have a very delicately devised wire that is heated red hot, and so sensitive that if you blow your breath on it it goes out. They put up six or eight of these wires at different points, all connected by electricity back to the central station, and then have a moving-picture machine. When an enemy gun goes off a button is pushed and the moving-picture machine goes into action, and as the vibration of that gun reaches each one of these stations there is a little quiver in the line that is printed on that film, and when it comes out it is handed over to the officer, and he goes to a carefully calculated table and proceeds to locate that gun by the vibrations taken miles away from where the recording instrument was, transmitted underground by wires buried six feet and brought back to this little encasement of his and printed; and those little strips of paper come back and locate the gun that fired that shot. Then he proves it by spot flashing, and as the sound travels from one place to another a number of people push a button, and, knowing that sound travels so many meters a minute, they prepare a map on which to locate it. Because paper expands and contracts, they make the map of zinc and they cut the paper in two-inch squares, so that nothing in accuracy shall be lost by the expansion or contraction of the paper under heat and dampness. They have a parabola around it with everything calculated, and stretch six strings around that, and when the six strings get over the same spot there is the gun, and when the other six strings get over there they are sure it is there, and then they get the airman to fly over it, and he can see if they are right, and it is nine out of ten if they drop a shot over there that that gun goes out of business.

---

*From an address by Maj. Gen. Charles M. Clement, U. S. A., before the Philadelphia Association of Members of the American Society of Mechanical Engineers.

No Middle Ground for Loyalty.

By H. E. Negley, Indianapolis, Ind.

When Nations stand at grips of death, amidst the Battle's pall;
When Valiant Soldiers pray for aid, and Suffering Peoples call;
When Hate and Crime usurp the place of Human Virtues grand;
There isn't any Middle Ground where Loyalty may stand.

When Fear and Famine stalk abroad, like Monsters of the night;
When Mothers, horror-stricken, weep at War's appalling sight;
When Innocence is common prey, and Murder foully planned;
There isn't any Middle Ground where Loyalty may stand.

When Virtue falls like broken reed, and Famished Children moan:
When Mercy leaves the human breast, and Malice reigns alone;
When breaking hearts beat unison in every martyred land;
There isn't any Middle Ground where Loyalty may stand.

When Reason on her broken throne, gives way to Lust and Greed;
When Avarice, with Power mad, makes helpless nations bleed;
When Passion, with its iron rule, is riding in command;
There isn't any Middle Ground where Loyalty may stand.

When Nation's Manhood marches forth to cope with Craven Foe;
When Womanhood gives up its all, and freely bids them go;
When Sacrifice exacts its toll, from us on every hand;
There isn't any Middle Ground where Loyalty may stand.

When Honor bids the nations arm, and save the Human Race;
When Treason from her slimy lair begins to show her face;
When Patriotism only stands against her Brigand Band;
There isn't any Middle Ground where Loyalty may stand.

Manufacturer's Record.

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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MONEY, MEN, SHIPS

Nothing of which history tells was ever sprung upon the world with more crashing suddenness than the war which is upon us. No greater task was ever laid upon a nation than that we shoulder now. Concentered upon us is the hope and the trust of the world, and without us none dares think what must have been the ultimate result.

This supreme, compelling, self-saving, world-saving, all absorbing business, which was not of our choosing but which we must perforce accept, is getting well under way with phenomenal unanimity of impulse and with unwavering confidence as to the outcome. The call is for all our strength and resource without the wasting of a day. Nothing that can obstruct or delay is for a moment to be allowed. We have no time to waste to talk of terms of peace or of what is to be done when the belching fires of hell shall have been quenched. The only thing to think of and to work for is to end the war, and in the only way possible that it should be ended.

The imperative call is for money, men, ships, and it is not easy to say which of these in our thoughts should precede the other, for each is indispensable. The money and the men we need not speak of here, for both being ready at hand could lavishly and promptly respond to the call.

With the ships the story is different, for they had all to be built; and the rush of the building speaks the momentum of the national purpose. Of old the building of ships was a slow and tedious process; now we do in a month what was the work of years. We are building ships of steel, of wood and of concrete, in old shipyards and in new, on both the great oceans and in the Gulf, all making records of achievement unthought of until actually accomplished.

The story of Hog Island shipyard when it can be written in full, we may well believe will have more incomparable things in it than any other. Think of the size of it, 900 acres, or the area of New York City from the Battery up to Cooper Institute or Wanamakers. And then, to begin with, the only requisite it had was waterfront. The ground was more swamp than anything else and had to be "made," so at once we have pile driving records, and records also of the collecting and depositing of material. Not only was the actual building of the ships to be provided for but there was also the catering to all the modern wants of the army of workmen. The total cost of the yard will amount to $50,000,000 and there are already placed with it contracts for the building of ships to the amount of $200,000,000. Five months, less one day, after the awarding of the contract actual shipbuilding was begun, the launchings are already frequent, and when the plant is in full swing a ship will be taking the water about every other day.

The completed shipyard will comprise 50 shipways and 7 outfitting piers, each of the latter handling four ships at once. The operations involved in the building of these ships are now entirely accomplished by mechanical means and very little old fashioned handwork finds place. The entire mechanical equipment would make a long list, electricity of course being the responsible power distributor. In the actual details of the working compressed air figures most largely, a brief enumeration of this installation being given elsewhere in our present issue. There are 17 large air compressors with an aggregate free air capacity of about 75,000 cu. ft. per min. There are many miles of air distributing pipes and 300,000 feet of rubber hose. This air is used to actuate about 2,500 pneumatic riveters of different sizes, 800 pneumatic drills and 1,800 pneumatic hammers, with all their various appurtenances.

It is scarcely possible to avoid speaking of the one Hog Island record which seems to be unique. The entire air compressing and air actuated equipment is supplied by a single manufacturing firm.

AERONAUTICAL INVENTIONS AND SUGGESTIONS

[The following compiled by *The Engineer*, London, for the benefit of English suggesters and would-be inventors, should be of equal value to a class not less numerous or less prolific in the United States.]

We are informed by the Air Ministry that the Air Inventions Committee, which was formed about nine months ago, has now received and examined upwards of 5000 inventions and suggestions relating to the Air Service. It is regretted that, owing to war conditions, a detailed account of the Committee's investigations cannot be published, but the following statement will, it is hoped, facilitate the work, both of inventors and of the Committee. It is realized that the information given is incomplete. It is appreciated also that inventors are placed at great disadvantages in present circumstances, for, unless immediately connected either with the Air Service or with aircraft manufacture, it is almost impossible that they should be acquainted with the most recent developments. So rapid has been the recent rate of progress that it is difficult, even for those in close contact with the Royal Air Force, to keep abreast of all the latest improvements.

LITTLE CHANCE FOR REVOLUTIONARY INVENTIONS

It may be noted in the first place that it is practically useless for inventors at the present time to submit inventions which would necessarily take a long period to develop; the requirements of war and the conditions of labor and material make it impossible for the Committee to support proposals of this nature. Generally speaking, and, as far as the period of the war is concerned, no very startling change in the present type of aircraft is anticipated, although improvements in parts and also in details are always possible, and may produce very important results.

The stage of development in construction which has now been reached is such that major improvements can only be expected from those possessing the requisite scientific and mechanical knowledge, skill and experience. Thus, radical changes in the shape of the wings of aeroplanes, the body, and the propellers are only possible after long and patient research carried out in aeronautical laboratories. Again, many inventors have forwarded proposals for helicopters aircraft of a similar nature, which, if an efficient design could be produced, would possess certain advantages—but probably not to the extent at one time imagined. Others have suggested flapping wings and rotary planes. Such schemes do not give any promise of being capable of development for use during this war, and, in any case, would require some years of experiment before they could be regarded as practical proposals.

As regards minor improvements, inventors should bear in mind that many details, such as turnbuckles, clips, etc., are now standardized, and that a change would only be justified by some very marked superiority. Safety devices for the machine and the pilot form a numerous class among the ideas submitted. The chief means suggested is the parachute, either applied by a harness to the pilot or directly attached to the machine. Those who have seen a passenger dropped by parachute from an aeroplane for exhibition purposes often fail to realize the conditions under which a parachute may have to be used as a safety appliance. The machine may be out of control, dropping at a velocity of 150 to 200 miles per hour, or spinning downwards in flames. Many other safety devices such as automatic stabilizers, wind brakes, etc., have been proposed at various times. The additional weight incurred by the use of any of the suggested safety appliances must remain a very serious factor so long as war conditions prevail.

ENGINE REQUIREMENTS

The engine is the heart of the aeroplane, and on its reliability depends the safety of the pilot. People acquainted only with motor car engine practice sometimes do not realize the exacting conditions under which an aeroplane engine must work. The engine has to be capable of running for the whole of the time of flight at its maximum power. The lubrication and ignition must be perfect, and the engine must not become overheated. The rating applied to aeroplane engines is its weight per horse-power, and engines are now being produced which show surprising results in this respect. Inventions which differ radically from present day practice—such as the internal-combustion turbine—have small possibilities of being adopted, for successive design and reconstruction entailing probably several years' work are necessary before satisfactory results can be expected. In view of the shortages of material and labor at the present time, no new type can be embarked on unless it is demonstrably superior to existing types, and possessed of definite and immediate advantages over them.

NOISE OF THE MACHINE

A subject intimately connected with the power plant is its noise. This noise constitutes one of the disadvantages of an aeroplane. For night flying a method by which it would be possible to hear from one aeroplane the approach of another would be of great advantage. The engine can be silenced without serious disadvantages, but the noise of the propeller and the hum of the wires are so great that silencing the engine is not sufficient to achieve the object in view.

Many proposals for the projection of bombs and grenades, of flame, and of poisonous gases have been received. The trailing bomb or grapnel for attacking enemy aircraft and submarines is a favorite suggestion from inventors. This device was tested before the war, and at various times since, but has been abandoned in favor of more effective methods.

Many hundreds of inventions and suggestions for inclinometers and instruments for straight flying and accurate bomb-dropping have been investigated. Efficient and well-designed instruments for these purposes have been available for some time past, but it is quite possible that improved forms may still be produced, though it is scarcely likely that this can be done by anyone who does not possess the scientific and mechanical knowledge required for an investigation of the nature involved. Some inventors of aeronautical instruments entirely disregard the action of centrifugal force upon pendulum and spirit level devices. Many gyroscopic instruments have been proposed which show the inventors to possess insufficient knowledge of the correct application and limitations of a gyroscope.

Anti-aircraft devices of various kinds are constantly being suggested, but the suggestions now contain very little new matter for consideration, and for the most part have received the careful attention of the authorities for a long time past, and have been the subject of much trial and experiment.

Any proposals of a practical nature which contain features of novelty and may be of utility are discussed with the assistance of the Air Service. The Committee fully appreciates the genuinely patriotic motives which inspire most of the communications which it has received, and it is with the object of encouraging the submission of useful and well-considered proposals that the information contained in this statement is issued for publication. Inventors should, however, bear in mind that the somewhat obvious proposals which might have been useful in an earlier stage of the war are now no longer serviceable. By following the general tenor of the above suggestions, inventors will greatly assist the Committee in the execution of its responsible duties.

MINES AND COUNTERMINES IN THE TRENCHES

By Capt. H. D. Trounce*

Our work in the Flanders trenches was almost entirely confined to mining. As soon as the Germans had been halted in their drive in August, 1914, they entrenched themselves, and wherever the trenches of the Allies were within 100 yards of their own they proceeded to start mining across "No Man's Land." Early in 1915 they exploded a large number of mines underneath the Allied trenches. The French and British immediately organized tunneling or mining companies and proceeded to countermine. During 1915 they were mostly engaged on the defensive in these operations below ground, but toward the end of 1915 and in 1916 and 1917 the Allies succeeded in reversing the state of affairs and were active with offensive mining.

When I reached the trenches early in the first week of January, 1916, the British company I was with had succeeded in sinking a number of shafts (not, however, without having several of them destroyed by the enemy during their construction) and had driven a number of galleries well over toward the Hun lines. Our trenches here opposite Fromelles averaged from 80 to 150 yards apart. On account of shallow water level, we averaged a depth of about 25 ft. below the surface, and only by constant pumping with hand pumps were we able to keep up the progress in our galleries. The soil was generally a blue plastic clay. At intervals we would strike running sand, and when this happened we usually found it wise to abandon the drive and start new workings. At the outset many of our tunnels also were destroyed by enemy "blows," but we succeeded in putting in quite an elaborate system in the course of time. The sector we were operating on had a frontage of approximately half a mile, and on this front we had about 16 shafts. From the shafts we drove a complete system of defensive galleries. Our main galleries were about 5½ ft. by 2½ to 3 ft. in cross section; branch galleries about 4½ ft. by 2½ ft. and with listening galleries or "rabbit holes," were usually in the form of a Y from the end of branch galleries and these were used principally for listening purposes.

ENEMY EASILY DETECTED IN CHALK OR FLINT

There is a marked difference between mining in clay and chalk. Later on in the Vimy Ridge area we had considerable mining in chalk. In clay it was possible for the Germans and ourselves to tunnel to within a few feet of each other before we could hear any sound of mining; and elaborate precautions were taken to insure silence. In chalk it is possible to hear from much longer distances, especially where the chalk contained any amount of flint.

To insure silent working in the clay we would use grafting tools instead of shovels. No nails were used in the timbering, all sets being wedged with sand bags. Blankets were hung in the end of galleries to deaden the noise. As we approach nearer to the enemy, the men working in advanced tunnels would have to use canvas shoes or work in their socks. No talking was allowed. Every precaution was taken to insure silent work. As the life of every one in the galleries depended on this, the work was conducted almost noiselessly. When we reached within striking distance of the enemy, we would build a charge chamber and load it with gun-cotton, connecting up with detonators and a double set of leads to the charge, and at the right moment fire these charges from the trench above by means of blasting machines. From this clay soil and at a depth of from 20 to 25 ft., we would blow craters 60 or 70 ft. wide with a small charge of 600 or 700 lbs. of guncotton. As a matter of fact, when we met the Hun below ground under "No Man's Land" we would endeavor to fire "camouflets," that is, a charge calculated to destroy enemy galleries but not to break the surface of the ground. We would usually carry on our work until we heard the Germans talking. When you can hear the enemy talking in clay you can bet they are pretty close. On some occasions we have in this way fired our mines when within three or four feet of enemy mines. In March, 1916, we broke into a German gallery and had a fight with them underground.

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*From *The Castle* published at Camp A. A. Humphreys, Virginia.

MINING AT DEPTH OF 150 FEET

Trench mining in clay is much more dangerous than in chalk, on account of the fact I have mentioned—the difficulty of hearing operations until one is almost on top of them. In the chalk country further south, in the Vimy Ridge trenches and the Somme area, we were mining at much greater depths. Some of our mines were 150 ft. deep, and after the battle of the Somme we found the Germans at Fricourt had a mine system 200 ft. deep. For these chalk mines we used a different and much stronger high explosive than guncotton. With the British, we used individual mine charges as large as 100,000 lb. These would blow cone-shaped craters several hundred feet in diameter and well over 100 ft. deep. Some idea of the terrific force of these mines can be obtained when you compare the bursting charge of the Mills bomb, which contains 4 oz., or ¼ lb., of ammonal, with the single mine charges of 100,000 lb., or 400,000 times that amount. You cannot see a hand bomb, like the Mills, burst without having some respect for its destructive qualities—particularly if you are close up.

Nearly all of our work on these Flanders mines was done by hand. At times our galleries and tunnels would be half full of water, and it required constant pumping, day and night, to carry on the operations. Hand water pumps and hand air pumps were used. Vertical shafts were sunk in this clay, usually of case timber, and light pit-prop sets were used for the galleries. All the dirt was handled in sand bags from the face, and brought out from the main galleries on rubber-tired mine cars and hoisted to the surface by windlasses. The sand bags were used for reveting and repairing trenches, which are being continually destroyed by enemy fire and action of the weather, and the surplus bags were emptied at night into shell holes and old mine craters.

We were fortunate, in our work below ground in not losing more men than we did, but it required constant and careful listening to avoid casualties. We could distinguish in time the nature of the sounds of the enemy miners when charging their mines, as distinct from everyday work, and mighty useful it was that we could do so. When we suspected the enemy were about to fire one of their mines, we would warn the infantry and have them withdraw any of their men who were on guard on top at threatened points. Sometimes they would keep us guessing, and would hold their mines, just as we did ours, for several days or even a week or two before firing them. The fact that mining is going on between the trenches is easily established after several weeks work, but every effort is made to conceal the exact location of the galleries.

LUBRICATION OF AIR COMPRESSORS

My experience with air compressors, which isn't a great deal, is that they require less oil (but a mighty good oil) than any other power plant machinery.

In the lubrication of an air compressor of more than one stage, I feed most of the oil to the first stage, very little to the second, and if it has three stages the third gets practically none.

The reason I do this is because the heat generated by the compression of the air in the cylinder vaporizes the oil and it is carried from stage to stage and does all its work. In an air compressor you have not the wiping effect on cylinder walls as in a steam cylinder, consequently less oil will do; but you must have a good oil and use it rightly. I tell by the condition of my valves how things are going. If they are dry or the least bit gummy, I give her a little more, and if they have an oil film that will penetrate two cigarette papers I leave her alone.

Above all things, do not clean your high pressure compressor with either gasoline or kerosene. Use bicarbonate of soda or soda water or soap suds. Feed this freely through the lubricator and follow with oil, making sure everything is getting oil before shutting down on account of leaving moisture in cylinders and valves while standing. Do this every two or three months. Bleed your air bottles and pipes for moisture. But get a good oil and use it judiciously. I have an 8 and 5 and 2⅜ by 8, three-stage compressor for fuel injector in a Diesel engine, which takes 2 qt. of good oil in two weeks, running 24 hours a day and 7 days a week. But no two will lubricate alike. Oil your air compressor independently from the rest of your engine and do not try to use reclaimed or filtered oil from either it or other machinery.—*Jack Stein in Power Plant Engineering*

GASES USED BY THE HUNS

Major S. J. M. Auld in the Journal of the Washington Academy of Sciences, gives the following list of gases used by the Germans:

1. Allyl isothiocyanate (allyl mustard oil) C_3H_5NCS (shell).
2. Benzyl bromide, $C_6H_5CH_2Br$ (shell).
3. Bromaceton, $CH_2Br.CO.CH_3$ (hand grenades).
4. Bromated methyl ethyl ketone (bromketone), $CH_2Br.CO.C_2H_5$ or $CH_3CO.CHBr.CH_3$ (shell). Dibromketone, $CH_3.CO.CHBr.CH_2Br.$ (shell).
5. Bromine, Br_2 (hand grenades).
6. Chloracetone, $CH_2Cl.CO.CH_3$ (hand grenades).
7. Chlorine, Cl_2 (cloud).
8. Chlormethyl chloroformate (palite), $Cl\ COOCH_2Cl$ (shell).
9. Nitrotrichlormethane (chloropicrin or nitrochloroform), CCl_3NO_2 (shell).
10. Chlorosulphonic acid, $SO_3H.Cl$ (hand grenades and "smoke pots").
11. Dichlordiethylsulphide (mustard gas), $(CH_2ClCH_2)_2S$ (shell).
12. Dimethyl sulphate, $(CH_3)_2SD_4$ (hand grenades).
13. Diphenylchlorarsine, $(C_6H_5)_2AsCl$ (shell).
14. Dichlormethyl ether, $(CH_2Cl)_2$ (shell).
15. Methylchlorosulphonate, CH_3ClSO_3 (hand grenades).
16. Phenylcarbylamine chloride, $C_6H_5NCCl_2$ (shell).
17. Phosgene (carbonyl chloride), $COCl_2$ (cloud and shell).
18. Sulphur trioxide, SO_3 (hand grenades and shell).
19. Trichlormethylchloroformate (diphosgene, superpalite), $ClCOCCl_3$ (shell).
20. Xylyl bromide (tolyl bromide), $CH_3C_6H_4\ CH_2Br$ (shell).

JACKHAMERS IN SOUTH AFRICAN MINES

In the annual report of the Robinson Deep mine, Transvaal, South Africa, the manager, J. J. Wessels, stated that during the year an improved method of stoping was evolved by the adoption of the jackhamer machine. Its use has resulted in a saving of native labor, and it is more economical in explosives than the reciprocating machine. The results for the six months ended Dec. 31, 1917, when an average of 28.5 jackhamers were in continuous use for stoping, show that the average fathomage per jackhamer was 12.4% higher than that of the reciprocating machine, the latter using approximately 100% more labor per machine shift and 86% more explosives per fathom broken. The reciprocating machine used 102% and the jackhamer only 9% more explosives per fathom than was employed in breaking rock by hand labor. During the period each jackhamer, employed an average of 1.25 natives, did the equivalent fathomage of seven hammer boys, so that the replacement by jackhamers of the 37,000 to 62,000 hammer boys employed at the Witwatersrand mines at various periods would save for other work a large percentage of the present native labor force. Dust tests showed that stopes operated by the jackhamer (which cannot be worked without water) and stopes operated by hand labor were about equal, though the stopes where the reciprocating machines were used were about 100% higher in mineral dust.

NOTES

The alternating current crane has one inherent safety feature not found in the crane with direct current motors, in that the motor is built with a predetermined fixed torque, and a heavier load than this maximum torque will handle cannot be lifted, whereas, with the series wound direct current motor, there is no limit to the load it will attempt to lift, and if excessively overloaded the motor will burn out provided some part of the hoisting mechanism does not fail.

Concrete depends for its strength upon securing the highest possible density. With a given aggregate and the same quantity of cement the strength of the concrete reaches its maximum with the smallest quantity of water that can be used to produce a plastic mix. Any increase in the amount of water is accompanied by a rapid decrease in the strength of the concrete.

Seemingly empty gasoline cans or tanks are probably more dangerous than those filled with gasoline. Usually the can is not entirely emptied, the remaining gasoline will vaporize, the vapor will mix with the air in the can, and the mixture may easily be explosive. When the can is being filled, this mixture is forced out by the gasoline and may explode if ignited by a flame or spark near the opening.

An interferometer is an instrument that makes use of the optical properties of gases, and is suitable for analyzing a binary gas mixture.

Remaining on the wing continuously for 30 hours and 30 minutes is the latest feat recorded in the world of aviation. This record as reported by the Navy Department at Washington, on August 2, was made by Ensign P. J. Barnes, who is attached to the American Naval Air Forces in European waters.

According to the U. S. Geological Survey, more sulphuric acid was produced in the United States in 1917 than in any previous year. A moderate estimate shows that the increase in the production of acid of all strengths in 1917 over that in 1916, stated in terms of 60-deg. B. acid, amounted to at least 600,000 tons.

What is said to be the largest hydraulic turbine so far built, or under construction, is to be installed by the Hydraulic Power Co., Niagara Falls. The normal operating conditions for which the turbine has been designed are as follows: Heads from 213 to 214 ft.; speed 150 r.p.m.; discharge, 1500 cu.ft. per second; capacity, 37,500 hp. It will be installed in the extension of the above-named company's Station No. 3.

Dyes developed at the chemical laboratory of the Rensselaer Polytechnic Institute, Troy, N. Y., are now being used by some of the big clothing concerns of the country. Since the German supplies of dyestuffs were cut off the chemists at the R. P. I. laboratory have been experimenting with different colors, and, it is said, have turned out many dyes, which, upon being tested, have proven the equal, if not the superior, of any dyestuffs imported from Germany before the war.

A unique method of loading hay into railway cars has been developed at Hermiston, Ore. The load is backed up against a deck or float beside the car, and the crane lifts the alfalfa from the wagon to this deck. A man then feeds into the cutting machine with a pitchfork, and a blower, propelled by gasoline engine, hurls the hay into the car. This machinery not only eliminates considerable human labor and saves time, but packs the hay probably better than a man could pack it with a fork. The blower is made on the same principle as the "cyclone" straw stacker used on grain threshers and gives the same satisfaction in use.—*Scientific American.*

The use of compressed air for transporting concrete for tunnel lining has ceased to attract attention because of its novelty. Now the air conveying process is being applied to other classes of concrete work. For example, P. J. Joyce & Co., of New York, contractors for the masonry work involved in the B. & O. grade separation project at Pittsburgh, have used the air method in building concrete retaining walls. A central plant was used to mix and force the concrete a maximum distance of 1,500 ft. through an 8-in pipe, using air at 80 to 100 lb. pressure. The concrete was first shot into a receiving hopper, carried on a traveler that straddled the wall, and thence was delivered by gravity through a flexible pipe into the Blaw steel forms which were also carried by the traveler.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE

1,268,816. COMPRESSED-AIR JACK. Warren J. Buchner and Raymond F. North, Glendive, Mont.

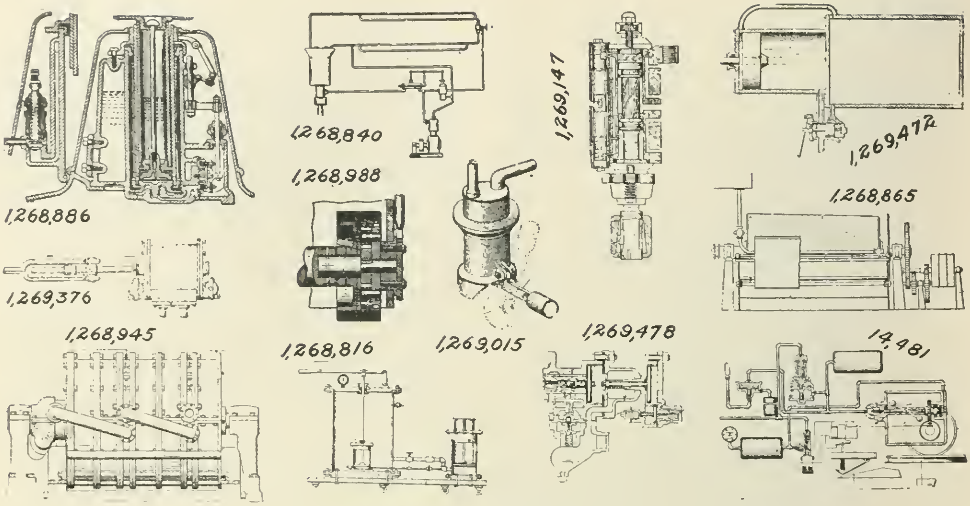
1,268,840. GAS-COMPRESSION PLANT. Arthur Heane, Blayney, New South Wales, Australia.

1,268,865. PROCESS FOR PRESSING YEAST. Ejnar Alfred Meyer, Clifton, Bristol, England.

1. A process of pressing yeast, consisting in depositing yeast in liquid form upon the surface of a revolving drum, then exhausting air from the drum to solidify the yeast on the drum, and then removing the relatively dry outer layer of the deposited yeast leaving a relatively damp layer on the drum to prevent the breaking of a vacuum within the drum.

1,268,886. CHAIR. Adolph W. Schramm, Riverton, N. J.

1. In an adjustable chair supporting means for the seat of the chair, a fluid chamber, a pressure supply for placing a fluid in said chamber under pressure to actuate the chair seat supporting means, a valve controlling



Pneumatic Patents June 11

said pressure supply, ports for the passage of the fluid, valves controlling said ports, operating means for said first and second named valves, and means operating automatically to center said operating means and to cause the said last-named valves to close off their ports simultaneously.

1,268,945. TURBINE-MOTOR FOR USE WITH COMPRESSED AIR. Gustaf Engelbrekt, Superior, Wis.

1,268,988. VACUUM-CLEANER. Francis C. Mason, Grand Rapids, Mich.

1,269,015. MILKING-MACHINE. Emil Starch and Benjamin Starch, La Crosse, Wis.

1,269,147. PERCUSSIVE ROCK-DRILLING APPARATUS. Richard Henry Adams, Cobalt, Ontario, Canada.

1,269,376. VACUUM-PUMP. Lionel Bull, Libertyville, Ill.

1,269,407. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, East Syracuse, N. Y.

1,269,472. FLUID-PRESSURE BRAKE. Richard H. McGeary, Allegheny, Pa.

1,269,478. FLUID-PRESSURE BRAKE SYSTEM. Frank L. Marston, Portland, Me.

1,269,535. ELASTIC-FLUID ENGINE. Reginald F. Halliwell, Rugby, England.

1. The combination with an engine adapted to be operated by low pressure elastic fluid, of a valve mechanism for controlling the flow of such elastic fluid, and regulating means for the valve mechanism comprising means responsive to the speed of the engine, and means responsive to the pressure of the low pressure elastic fluid, and a manually operable device for moving the valve mechanism independently of said regulating means, whereby the effective action of the regulating means on the valve mechanism may be varied.

1,269,540. ELASTIC-FLUID TURBINE. Fredrik Ljungstrom, Stockholm, Sweden.

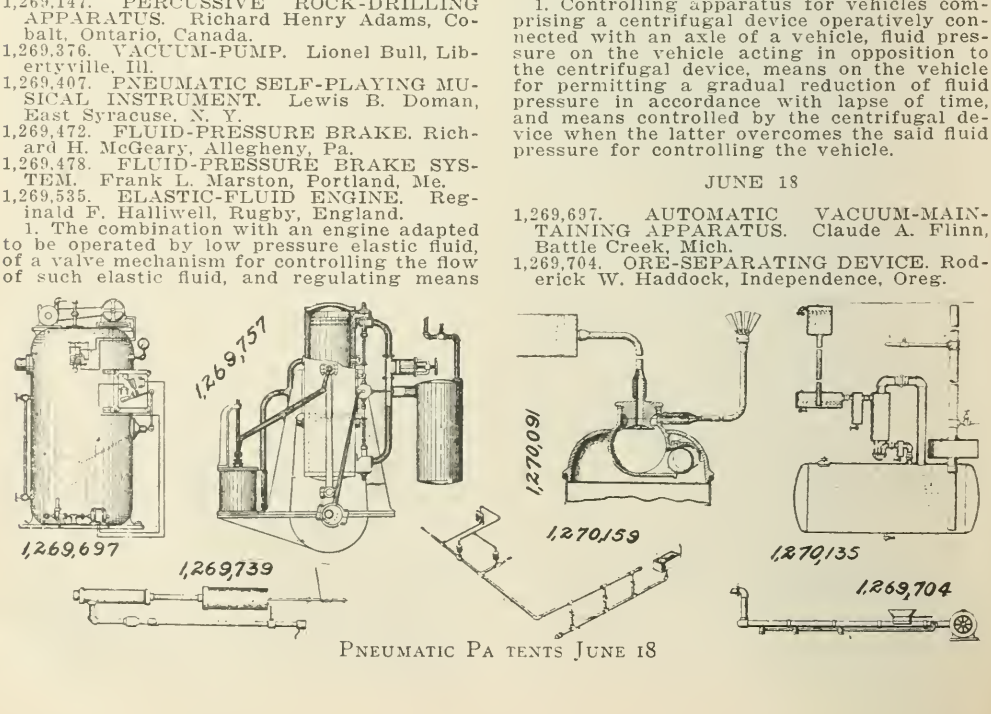
14,481 (Reissue). SPEED-CONTROLLING APPARATUS FOR RAILWAY-VEHICLES. Lloyd V. Lewis, Edgewood borough, Pa.

1. Controlling apparatus for vehicles comprising a centrifugal device operatively connected with an axle of a vehicle, fluid pressure on the vehicle acting in opposition to the centrifugal device, means on the vehicle for permitting a gradual reduction of fluid pressure in accordance with lapse of time, and means controlled by the centrifugal device when the latter overcomes the said fluid pressure for controlling the vehicle.

JUNE 18

1,269,697. AUTOMATIC VACUUM-MAINTAINING APPARATUS. Claude A. Flinn, Battle Creek, Mich.

1,269,704. ORE-SEPARATING DEVICE. Roderick W. Haddock, Independence, Oreg.



Pneumatic Patents June 18

1. In an ore separating device, the combination of a main piping, a plurality of sectional short pipings positioned in the same plane as the main piping, said short piping being substantially parallel, U shaped elbows connected to the ends of said short piping, tubular members carried upon said short piping, short pipes connected to said tubular members, said short pipes extending at right-angles to each other, thus causing abrupt abutments for the particles of ore being drawn through said piping and pipes by air, so as to cause the minerals to be readily deposited in said tubular members.

1,269,739. FLUID-PUMP Lewis A. Payton, Haskew, Okla.

1,269,757. APPARATUS FOR PROPORTIONING THE CHARGE OF FUEL AND AIR IN INTERNAL-COMBUSTION ENGINES. Lyman S. Stevens, Baltimore, Md.

JUNE 25

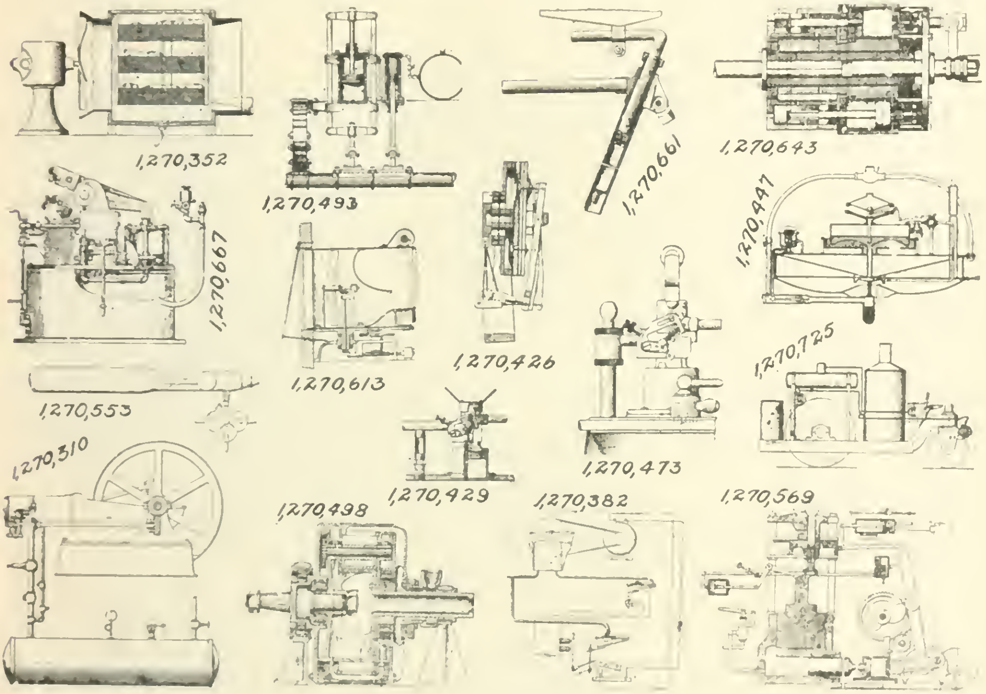
1,270,310. APPARATUS FOR COMPRESSING ELASTIC FLUIDS. Milton McWhorter, Playas, N. Mex.

1,270,352. VENTILATING AND COOLING APPARATUS. James A. Williams, Roxbury, Mass.

1,270,382. AUTOMATIC CONTROLLING DEVICE FOR THE MOTORS OF PNEUMATICS. John A. Weser, New York, N. Y.; Elsie L. Weser, administratrix of said John A. Weser, deceased.

1,270,426. PNEUMATIC MOTOR. Frank G. Lynde, Newark, N. J.

1,270,429. PULSATOR FOR MILKING-MACHINES. Arthur Chichester Macartney, Bloomfield, N. J.



Pneumatic Patents June 25

1,269,931 METHOD OF DRYING VARNISHED PATENT-LEATHER. Ernest Hintz, Wiesbaden, Germany.

1 Method of drying varnished (patent) leather and the like consisting in exposing the material to be dried under exclusion of all atmospheric air or other oxidizing agent to the action of light of short wave length and rich in ultraviolet rays.

1,270,091. MILKINK-MACHINE. George V. Andrew, Harvard, Ill.

1,270,135. STATIONARY CHEMICAL-MIXING FIRE-EXTINGUISHER SYSTEM. John W. Enright, New Orleans, La.

1,270,159. AUTOMATIC CONTROL FOR HUMIDIFYING APPARATUS. William B. Hodge, Charlotte, N. C.

1. In a humidifying system, a source of pressure supply, a distributing line for said pressure supply, and means for exhausting the working pressure in the line simultaneously with the shutting off of the main pressure from said source.

1,270,447. APPARATUS FOR COMPRESSING GAS OR AIR. Charles Scott-Snell, Ridgway, Wimbledon, England.

1,270,473. PULSATOR FOR MILKING-MACHINES. Robert Warnock, Bloomfield, N. J.

1,270,493. VEHICLE AIR-CUSHION COMPRESSOR. John J. Campodonico, Stockton, Cal.

1,270,498. ROTARY ENGINE PUMP, COMPRESSOR AND THE LIKE. Bruce Conklin, London, England.

1,270,553. AIR-BRUSH. John Rouge, New York, N. Y.

1,270,569. PRESS. Preston Upham, Boston, Mass.

1,270,613. VENTILATOR AND AIR-PURIFYING APPARATUS. Frank A. Gustavson, Seekonk, Mass.

1,270,643. FLUID TRANSMISSION Mark H. Massuere, Cheyenne, Wyo.

1,270,661. PNEUMATIC SADDLE-POST AND PUMP. Lowerre B. Reed, Rutherford, N. J.

1,270,667. ROCK-DRILL SHARPENER. William A. Smith, Denver, Colo.

1,270,725. STREET-ROLLER. John Gratton, San Francisco, Cal.

JULY 2

1,270,803. WINDMOTOR. William F. Folmer, Rochester, N. Y.

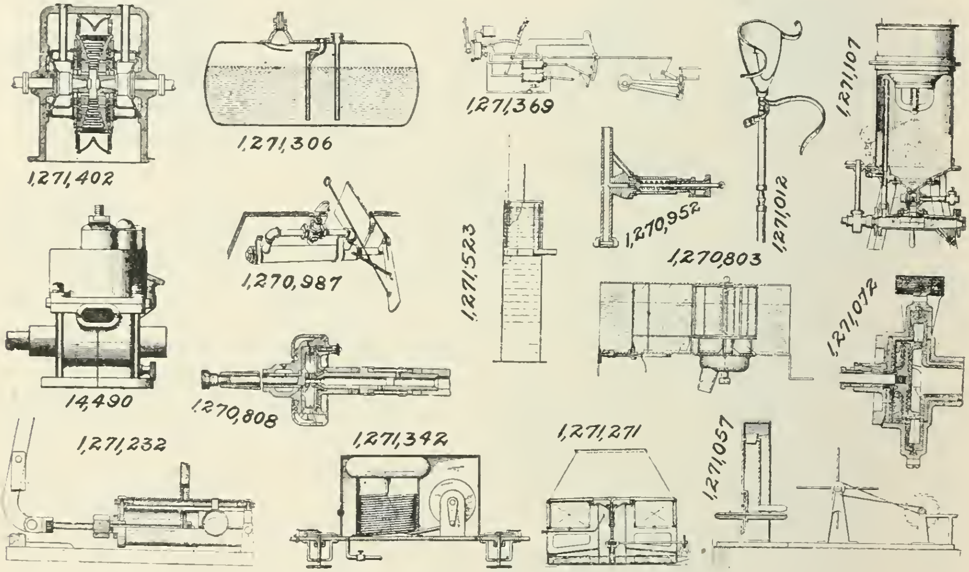
1,270,808. ROTARY TOOL. Charles H. Franklin, Schenectady, N. Y.

1,270,952. TIRE-PRESSURE VALVE AND SIGNAL. Guerdon O. Jones, Bouton, Iowa.

1,270,987. FLUID-CONTROLLED SWITCH-OPERATING MECHANISM. John Bell Stroud, Pass Christian, Miss.

1,271,012. BREATHING AND FACE-PROTECTING APPARATUS FOR ROCK-DRILLS. Aime Blanc, Aspen, Colo.

1,271,057. TRICK TOY. Henry Millhouse, Chicago, Ill., assignor of one-half to George Victor Lillig, Chicago, Ill.



PNEUMATIC PATENTS JULY 2

1. A toy comprising a wind motor, a blowpipe positioned to discharge on the motor, a mouthpiece for the blowpipe slidably mounted to come into and out of registry therewith, a powder receptacle having an outlet and an air inlet aperture, and a cover plate for the inlet aperture carried by the mouthpiece, said plate covering the aperture when the mouthpiece registers with the blow-pipe, and said mouthpiece registering with the aperture when slid out of registry with the blowpipe.

1,271,072. FLUID-PUMP, TURBINE, AND THE LIKE. Richard Clere Parsons, London, England.

1,271,107. SPRAYING APPARATUS. Carl Weller, Zurich, Switzerland.

1. A spraying apparatus, such as a sandblast machine, white-washing or painting sprayer and the like, comprising a spraying material tank, a compressed air feed-pipe, a mixing-pipe connected to said feed-pipe, means provided with a passage for the spraying material and adjustably arranged between the material tank and the mixing pipe, a member removably secured to the spraying apparatus and a cleaning-pipe.

1,271,188. PNEUMATIC ACTION. Frank G. Lynde, Newark, N. J.

1,271,193. PNEUMATIC ACTION FOR PLAYER-PIANOS. Harry Meyer, Wellston, Mo.

1,271,197. MINING-MACHINE. Edmund C. Morgan, New York, N. Y.

1. In a mining machine, a main frame, a reciprocating mining tool mounted thereon for universal movement, and means for actuating said mining tool, in combination with fluid-pressure power-actuated mechanism for advancing and anchoring said main frame.

1,271,232. AIR-PUMP. George Scriver, Creemore, Ontario, Canada.

1,271,271. APPARATUS FOR COOLING, HUMIDIFYING, AND FILTERING AIR OR THE LIKE. Henry Francis Brown, Sheffield, England.

1,271,306. AIR-MOISTENING DEVICE. David J. Fox, Boston, Mass.

1,271,342. APPARATUS FOR RAISING SUNKEN VESSELS. John W. MacDonald, Portsmouth, Va.

1. In apparatus for raising sunken vessels, a guide rope having one end secured to the vessel, a float connected to the other end of the guide rope, a casing inclosing said float and guide rope to hold the same upon the vessel, means for introducing air under pressure for releasing said casing, guide rope and float in the event of the sinking of the vessel whereby the float may rise to the surface of the water, and means adapted to traverse said guide rope and engage the vessel whereby the latter may be raised.

1,271,369. REVERSING-GEAR FOR FLUID-MOTORS. Minor L. Robinson, Villa Grove, Ill.

1,271,402. ELASTIC-FLUID TURBINE. Oskar Anton Wiberg, Finspong, Sweden.

1,271,523. APPARATUS FOR MEASURING THE QUANTITY OF EXPIRED AIR. Haydn Brown, Chislehurst, England.

14,490 (Reissue). FLUID-PUMP. George W. Kellogg, Rochester, N. Y.

1. In a pump, the combination with a base having an oil chamber located therein, of a cylinder arranged on the base, a piston reciprocating in the cylinder, and a baffle located at the bottom of the cylinder to prevent oil splash from the oil chamber to the cylinder walls but adapted to receive oil on its upper surface, whereby efficient lubrication is provided and excessive lubrication prevented.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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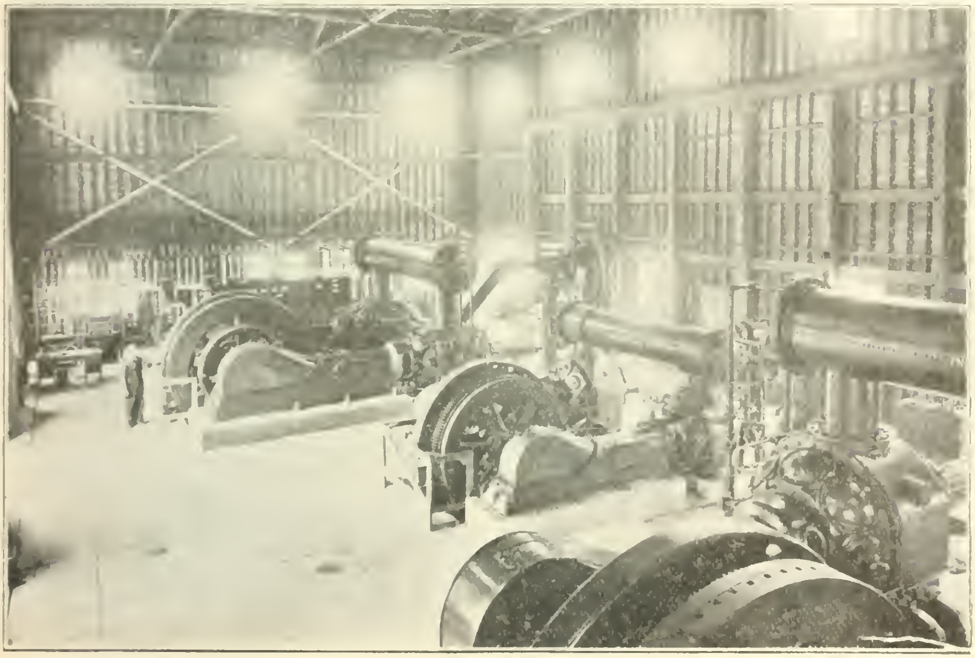


ONE OF THE FIVE COMPRESSOR INSTALLATIONS

HOG ISLAND COMPRESSED AIR INSTALLATION

For the following information, with the admirable photos accompanying, we are indebted to Mr. T. Holbrook, President of the American International Shipbuilding Corporation. A portion of the matter is a repetition of our preceding issue, but it is considered better to present it here entire to give a good understanding of the illustrations. The numbers of these pictures in existence is already immense and they are being added to daily and they will form a historical record of inestimable value. Many motion pictures also are being produced. To give a completely realistic effect these should be accompanied by phonographic reproductions of the rattle of the pneumatic tools. There are many, however, who would prefer not to be at once both spectators and auditors.

The Compressed Air System at Hog Island is planned to furnish compressed air at 100 lbs. initial pressure for all necessary uses on the ships while on the ways and at outfitting piers, to the shops and to the Training School.

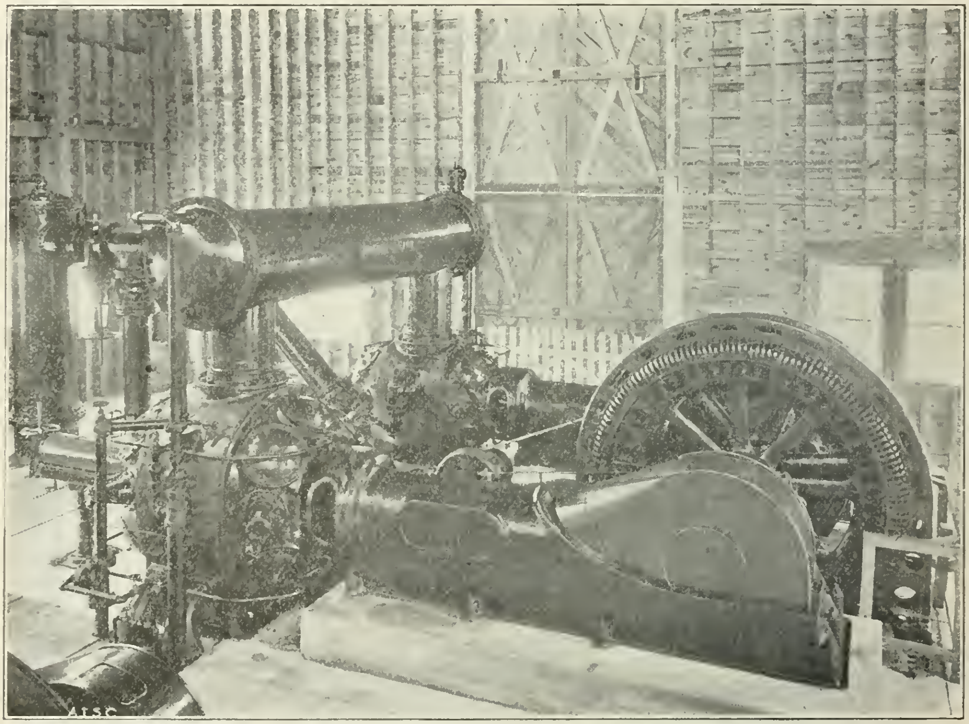
In general, the system consists of a 10 in. standard steel pipe main, extending along the head of the shipways, parallel to Front Street, and 98 ft. distance therefrom. This main is subdivided by sectionalizing valves; and provision for expansion and inspection is made by the introduction of generous "U" Bends and the use of a Box Trench, the cover of which is easily removable. From this 10 in. header, two six inch lines are taken down each shipway, running parallel to the keel blocks, and on each side of them. A tee and manifold with outlet cocks is inserted at each random length.

Another main six inches in diameter extends along the Marginal Wharf of the Outfitting Piers, under West Second Street, and 3 in. branches are taken down each side of each of the piers. Outlets similar to those on the shipways are inserted in these branch lines. The 6 in. main and the 10 in. main are connected together.

At intervals along the 10 in. main, approximately at the mid-point of each group of ten ways, an air compressor plant feeds the system through a 12 in. pipe line. These five compressor plants are identical, and contain the following equipment:

Two Ingersoll-Rand Class PRE-2 Air Compressors, each 40 in. and 25½x30 in., direct connected to a 1020 h. p. General Electric 4,000 volt, 3 phase, 60 cycle synchronous motor, having a speed of 138½ R.P.M. The actual delivered capacity of each of these compressors is 5,320 cu. ft. free air per minute.

One Ingersoll-Rand Class PRE-2 Compressor 28 in. and 17½x21 in., direct connected to a 450 h. p. General Electric 4,000 volt, 3 phase, 60 cycle synchronous motor, having a speed of 180 R.P.M. The actual delivered capacity of this unit is 2,275 cu. ft. free air per minute, making the total capacity of each of the five plants 12,915 cu. ft. air per minute.



ONE OF TEN LARGE AIR COMPRESSORS

The larger compressors are equipped with after-coolers of, approximately, 1,005 sq. ft. cooling surface, and the smaller with an after-cooler of 505 sq. ft. cooling surface. One air receiver of 430 cubic foot volume, to act as a separator and to dampen pulsations, is installed for the complete plant. Each compressor is mounted on a massive concrete foundation, supported by piles.

Intake air is drawn through a wooden box intake on the outside of the building from a point above the eaves down the side of the building into cast iron or salt glazed tile pipe, cast in the concrete foundations. A suitable piping system is installed for leading the discharge air from the compressors to the receiver. It is made up of extra heavy material, using Van Stone joints.

10-INCH MAIN AIR PIPE WITH U BEND FOR EXPANSION

A system of waterpiping is also installed for furnishing cooling water for the compressor jackets, inter-coolers and after-coolers, and for discharging the same into the Delaware River. Proper indicating and recording thermometers and pressure gauges are installed in the pipe lines to register the temperature and pressure of air and water. It is proposed to insert an air flow meter in the discharge line from each compressor plant, between the receiver and the 10 in. air main to register the output of the individual plants.

Installation of the compressors, and later maintenance of the same is facilitated by a 10 ton hand operated traveling crane, which spans the width of the building.

Each compressor motor is belted to an individual exciter of 15 and 10 K.W. capacity respectively. A modern switchboard with indicating and recording instruments is installed for starting and controlling the motors and exciters.

Remote manually controlled General Electric, type K-12 oil switches are used, being connected to the fuses through air break disconnecting switches. Double fuses and duplicate starting compensators are installed.

Two oil storage tanks of two barrels ca-

REAMING HOLES IN DECK PLATES

pacity, equipped with self-measuring pumps are installed for the proper storage and handling of necessary lubricating oil.

In addition to the five foregoing compressor plants, there are two smaller plants which feed into the 6 in. air main at the head of the Outfitting Piers, at points best calculated to serve it properly. These two plants are like the others, excepting that they contain only two of the smaller capacity compressors, making the total capacity of each plant 4,550 cu. ft. of free air per minute. The entire air compressor capacity of the combined plants is 73,675 cu. ft. of free air per minute.

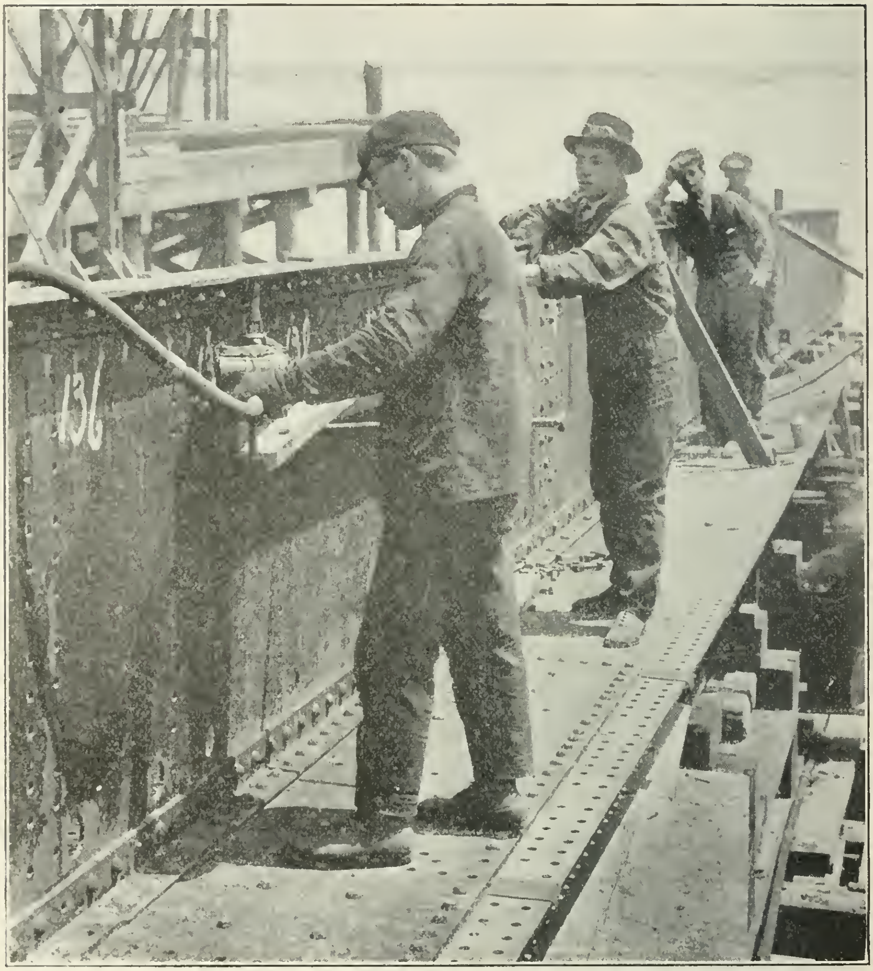
The compressor houses also are used as high voltage sub-stations, each serving demands for electric power in its immediate neighborhood. Provision has been made to

DRILLING HOLES IN BULKHEAD

enable the ready enlargement of any plant, either mechanically or electrically.

The compressor capacity installed is expected to supply sufficient air on the ships to operate pneumatic tools which have been purchased in accordance with the following schedule:

1675. No. 60 Riveters.
100. No. 90 Riveters.
1325. No. 5 Holders-on.



COUNTERSINKING HOLES FOR FLUSH RIVETS

200. No. 1 Jam Riveters.
480. No. 2 Non-reversing Pneumatic Drills.
400. No. 3S Non-reversing Pneumatic Drills.
50. No. 1B Non-reversing Pneumatic Drills.
200. No. 9 Corner Drills.
150. No. 5 Breast Drills.
100. No. 1S Chipping and Caulking Hammers.
1230. No. 2SS Chipping and Caulking Hammers.
500. No. 3S Chipping and Caulking Hammers.
50. No. 7 Grinders.

In addition to these tools, there are at present 800 rivet heating forges which operate from the compressed air lines. These forges, however, take only a small portion of the entire volume of air required for their operation from the high pressure system, and induce the rest from the atmosphere. Other equipment auxiliary to the pneumatic tools are about 300,000 lin. ft. of rubber hose, 6,500 sets of Bowes pneumatic hose couplings 150 bottom riveter frames, 15,000 rivet sets and 12,000 chisel blanks.

An air tool house has been located at the head of each group of five shipways for the storage and maintenance of the air tools. These buildings are equipped with storage

INNER BOTTOM PLATES, CAULKING A SEAM

racks for the different types of tools besides grinding and lubricating machinery.

Compressed air for use in the shops is obtained from the 10 in. air main by means of 6 in. tap lines.

The Training School is equipped with one 600 cu. ft. Imperial Type Ingersoll-Rand Compressor, belt connected to a 100 h.p. squirrel cage motor. As an additional source of air supply a 6 in. pipe line is run underground making connection to the 10 in. air main along the head of the ways. A tap is also taken from this 6 in. line to the similar line feeding the Shop Group, so that the latter may get air in two ways.

The Norwegian State whaling stations have caught 200 whales but expect to catch in all 500 during the summer. The stations have orders to take care of the intestines and salt them down, as it is the intention to make gloves of them. The material is fine in every respect, pliable, soft, and exceptionally strong.

BROMINE IN THE WAR GASES

The element bromine does not occur in native form, but is derived in large quantities from natural brines. It exists in all sea water and in most mineral water and salt springs, and has been found in giant kelp (sea-weed). Bromine is at ordinary temperature a volatile heavy mobile liquid of a reddish-brown color, giving off reddish-brown vapor. The vapor when inhaled dilute resembles chlorine in smell and in attacking the throat and nose, but in addition it has a very harmful effect on the eyes. The liquid is very poisonous and produces burns on the skin. Bromine is used in many chemical reactions as an oxidizer instead of chlorine, also in dissolving gold and separating it from platinum and silver, and in manufacturing disinfectants, bromine salts and aniline colors. Perhaps the best known and most widely used bromine salts are bromide of silver, used in photography, and potassium bromide, used in medicine where it is desirable to depress the nervous system Because

RIVET HEATER AND SPECIAL RIVETER

of its harmful effect on the eyes, nose and throat, bromine is now used in large quantity for grim purposes of warfare.

AUTOMATIC LIGHTHOUSES

During the last few years a number of new lighthouses have been built along the coast of Queensland, Australia, inside the Great Barrier Reef, and as life in the tropics is disagreeable even under favorable conditions, it was thought advisable to eliminate the human side if possible, and accordingly the Aga system of unattended lights was adopted. Acetylene dissolved in acetone at 10 atmospheres pressure is used, and there are ten cylinders, each containing 117 cubic feet, all coupled together. They are changed once a year. The light is turned on and off by a sun-valve, which is so delicate that the light has been seen to come into operation during a rainstorm. A pilot flame is always burning. The lights are of 1,500 candle power, with a visibility of 13 miles. So far—*i. e.*, since 1913—no trouble has been experienced with any of those unattended lights. The first cost compares favorably with that of a manned light, and the running cost is only about one-twentieth.

RUSHING A BRITISH SHIPYARD

When the history of the efforts made by British shipbuilders to increase the output of vessels to make good those lost by submarine attack comes to be written, few achievements will take a more prominent place than that of the Furness Shipbuilding Company, which has transformed within the space of a few months a site of ninety acres "somewhere on the North-East Coast" from grass land to a fabricating shipyard with four keels laid on the blocks.

In the middle of March of this year, horses and cows grazed on the site of what is now a shipyard. Permission had been given to the company to proceed with the work at the end of last year, and the intervening time had been occupied in preparing and digesting the plans of the undertaking. Then one morning the horses and the cows disappeared and their places were taken by gangs of workers whose aim was to show that a British yard with eight berths could be built and equipped in from eight to nine months. The feat was by no means easy. The selected site was below the level of the river at high tide. Before a ship could be launched, the whole area had to be raised by some 12 ft. or 15 ft., but the builders of the yard were confident that the task could be accomplished, and accomplished too, to a prepared schedule of time. Events have justified them in their optimism. Whenever a date was set for the accomplishment of a task, that date has been strictly adhered to.

The work was begun in March; the middle of July finds four of the eight berths already in use, and the concrete bed of a fifth well advanced. From the outset, the one object of everybody has been to save time. Those in authority solved that problem by never leaving the work for weeks together; they worked in railway carriages; they took their meals in railway carriages; they slept in railway carriages; and they were always at hand to face any emergency. The problem of feeding the 2,000 workers had to be tackled. In eleven days a canteen was built, and though on the eleventh day there were no windows and no roof; a three-course dinner was served to the workmen.

WOMEN HANDLING SHIP MATERIAL

WOMEN DIGGING A SHIP BASIN

WOMEN ON THE JOB

Whenever a difficulty arose it was dealt with immediately. A large body of the men was suddenly absent from their work; the next day their places were taken by women, who have worked splendidly ever since. Then the management found that there were far too many cases of sprained ankles among the women, who used to arrive at their work in high-heeled boots and shoes. A standard boot was designed, and sprained ankles are no more. These are trifling matters, perhaps, but they help to explain why the building of the yard is now proceeding with clock-work regularity.

The new yard is situated on the bend of a river, and the eight slipways can take vessels up to 650 ft. long, which will be launched down-stream. For the present only "fabricated" ships of standard pattern are to be built, the parts being made, as a general rule, at the steel works which abound in the immediate neighborhood. The steel as it arrives is dumped down on a spot on which a few weeks ago there was a mountain of slag. The contents of the latter is being used to raise the ground to the necessary level, a work which proceeds at a remarkable pace. As each section is completed it is handed over to the builders to begin the erection of the berths.

Standing on the high ground by the river one can watch the whole work in progress. At one end the grass is still growing, for the ground has scarcely been touched. A little farther on the land is being filled in by women workers, and elsewhere other women are at work on the site of a wet basin which, when finished, will be able to take several vessels simultaneously for the fitting of the engines and boilers. On a slipway, where the bed for the keel blocks is rapidly nearing completion, girls are helping at the large concrete mixers; at another berth the keel has already been laid, and the riveters are hard at work, while at the two farthest slipways the centre keelsons are in position, and electrically driven cranes are bringing up the fabricated parts. In the background are the ambulance station, the general offices, consisting of two rows of railway carriages, and the canteen, while the foundations of a number of model cottages for the use of married workers and of a hotel which will accommodate 1,000 men are also visible.

As to the capacity of the yard, the idea is that a ship a fortnight shall be built, and when the yard is in full operation the management is convinced that this output is possible. If all goes well the first fabricated ship will be launched in November, and thereafter it is hoped that a new hull will be put into the water ever two weeks.—*The Engineer,* London.

TRICKS AND ACROBATICS IN AIR FIGHTING

Were speed the only criterion by which to judge the most likely winner of an aerial combat, then the aviator mounting the fastest machine would always be the victor. And that is as much as to say that the Allied aviators would always win, because of late their machines are almost always faster than the German ones. But speed and climbing ability are only two factors in aerial combat; besides, there are markmanship and maneuvering skill. It is safe to say that the last-mentioned factor, maneuvering skill, is by far the most important in aerial combat. Both when on the offensive and on the defensive the aviator who knows every trick of his profession stands the best chance of winning or escaping.

It is due to the fact that tricks are an indispensable part of the air fighter's training that only the best of aviators are chosen for combat work. Indeed, as the training progresses from the safer to the more dangerous trick machines, more and more students drop out and are used in other branches of the air service, such as for reconnaissance and bombing work. The pick of the men—the daredevils, if you please—remain.

In the French flying service the combat or *chasse* pilots are sent to a finishing school at Pau, after graduating from preliminary flying schools. At Pau, under the direction of none other than Lieut. René Simon, who will be recalled as the daring exhibition flier of the early days of aviation in the United States, the pilots who have already mastered flight on slower mounts are put on diminutive but speedy Nieuport biplanes. From the Nieuport with a wing area of 18 square meters, the pupil advances to the 15-meter and finally to the 13-meter. Needless to say, the diminishing wing surface makes for greater speed, but at the same time the machine becomes more difficult to fly because of its poor gliding qualities. Such a machine lands at a terrific speed, and not as the larger planes which can volplane gracefully with their motors barely turning over.

Individual instruction is given at the Pau school of aerial acrobatics. Lieut. Simon explains the "stunts" one at a time to each student who must repeat the instructions until every movement is committed to memory. Then the student takes the air with his diminutive biplane and performs the "stunts" with the instructor and other pupils watching on.

Now the greatest of all "stunts" appears to be the so-called "vrille," which is a sort of twisting or corkscrew tumble as of a machine falling out of control. It used to be the practice to teach the "vrille" last, but now it is taught first. For once the student has tried to master the "vrille" he no longer has fear for other "stunts."

To make his first "vrille," the student ascends to a height of over 800 meters and after flying on a level course for a short while, he switches off his engine and at the same time pulls the control stick back towards him and

SOME AEROPLANE STUNTS

towards one side, while pushing on the rudder bar either right or left with his feet, depending on which side the control stick was directed. As a result the biplane swoops upward, loses its speed, stalls, and then falls over to one side with a twisting or corkscrew movement like a falling leaf. The sharpness of the movement can be varied according to the rudder pressure being utilized.

To come out of a "vrille" the pilot replaces his control stick in the center position and brings the rudder bar back to normal, and then pushes the control stick forward a few inches. The machine soon ceases to corkscrew, points forward, and dives straight down. It is then by reversing the control stick that the pilot brings the machine to an even keel again and switches on the engine. The "vrille" is done to the right and the left, while the ever-watchful Lieut. Simon waits for the pilot to land, in order to comment on the performance. Only one machine is in the air at a time.

The "renversement" comes after the "vrille." This trick is a change of direction without loss of height and, in the case of a skilled pilot, without reducing speed. The pilot ascends to above 800 meters and after flying on a level keel for a few minutes, he points the machine slightly down so as to bring the speed up to maximum. Then he brings the control stick back about half way and reduces the motor speed in order not to perform the "stunt" too rapidly. Then, when the machine appears to lose some of its speed the rudder is turned sharply to one side and the machine immediately falls to that side. When in the vertical position the airman brings the rudder to the center position, opens the engine wide, and returns the machine to a level keel. It will be noted that in the "renversement" the ailerons are not employed, as contrasted with the "vrille."

When being pursued a pilot sometimes resorts to the trick known as the "changement de direction" in French aviation circles. As in the instance of the "renversement," this turning maneuver can be executed without loss of speed or height. In describing this "stunt" in a recent issue of *Flying*, Lieut. Granville A. Pollack, U. S. A., late of the Lafayette Corps, states that it is a valuable but rather rare maneuver.

Flying level at full speed, the necessity to return suddenly is met by throwing the control stick very quickly to one side, as far as it will go, and then immediately pulling hard back toward the pilot, accompanied by a very slight pressure of the opposite foot and only just sufficient to hold the tail level, or it will be inclined to fly forward. The result is very startling for the first time, for the pilot feels as though he were being forced through the seat, so strong is centrifugal force acting, yet in reality he makes a comparativly wide bend, not unlike a hairpin. This "stunt" is also done three or four times and either to the right or to the left, at the acrobatic school for airmen.

A wing slide follows, which is done by throwing the control all the way to one side, and accompanying it by pushing the opposite foot sharply ahead, sufficient to hold the nose of the machine up, and at the same time slightly pushing forward the control stick, which gives the effect of traveling on the "outside" of the circle, and the machine descends sidewise at a terrific speed, much faster than it goes ahead, but with the pilot following practically a straight course forward.

A fifth trick, that of "retournment," is performed, very similarly to a "renversement," but instead of coming out in the opposite direction the movement is continued until one is again on the original course To commence, the pilot does as in the "renversement," pulling the control stick back, the machine mounting sharply, and giving the rudder a kick. Then the tail goes up as the machine starts to fall to one side; but now, as the position approaches the vertical, the foot is only partly recovered, while the control is pulled moderately to the same side, as used by the rudder, which produces a half spin sufficient to bring the machine back to the former direction. It is important that the aileron should be used here, for if the rudder alone is used the movement will be too slow to be of value in a fight, and will result in loss of considerable height.

Here it should be understood that, when done properly, all these maneuvers, excepting the wing slips, should be done without appreciable loss of height, and therefore quickly; and so as an indication of the development of a pilot's "reflex," aerial acrobacy is beyond doubt conclusive evidence.

Last, and by far the most difficult to execute, is the horizontal "vrille" or barrel roll, as it is often called, which is very spectacular but the use of which in combat is questionable. This is usually started by slightly reducing the speed of the engine, pulling the control stick well towards the pilot, and giving a very quick push at the rudder—to the full extent, in fact—and at once replacing all controls in the center. The machine starts to mount suddenly, but the full effect of the rudder swings the machine up on one wing, over complete sideways, which follows with a wing slip and a flattening sidewise. The whole presents a most striking effect, and unless the pilot is quick it generally results in a loss of speed and a "vrille."

Looping is not encouraged in military aeronautics, for the reason that as long as the machine is inverted the pilot is helpless and presents a good mark to his opponent. Furthermore, the machine guns are apt to jam as a result of the maneuver.

A "stunt" frequently employed at the front is the upward swoop followed by a tail slide. When a machine is being pursued by another which is blazing away at the tail of the first, the usual maneuver for the first pilot is to pull the control stick backwards, heading his machine straight up until it attains a vertical position. Here it "hangs" by its propeller for just an instant, as is strikingly shown in our cover sketch, when it slides back and is finally brought into the level position again. Now it is behind the opponent and possesses the advantage.—*Scientific American.*

COMPRESSED AIR TO WIN THE WAR

By Frank Richards

Concluded from page 8871

And yet compressed air will not do everything; and this begins a story very different from that we have been rehearsing. It was demonstrated a score of years ago, to the satisfaction—or the dissatisfaction—of everybody interested, that compressed air can never be a success for driving street cars. We must not forget, however, that there are lots of compressed air mine locomotives giving good satisfaction. One of the later and decisive demonstration failures of compressed air street cars, which took place in New York, was really a prelude to a great success in another direction, and, as may appear, a long-distance shot at the Kaiser and his crew.

LIQUID AIR

The failure of the compressed air street cars in New York threw a three-stage, high pressure air compressor out of business, and permission to use the compressor gave Chas. E. Tripler his opportunity to be the first to show the world that liquid air can be produced on a practical commercial scale.

It has never been clear to the world how Tripler got hold of the trick, for he had none of the qualifications which might have been presumed to be indispensable, and his inability to follow up the matter was pitifully exhibited; but he did make liquid air accessible to experimenters in various colleges and elsewhere, and its peculiar properties came at once to be generally familiar; but for a time it was a curiosity only, and no one could suggest to the world what to do with it, so Tripler did not realize a fortune.

Liquid air, however, at the time of the Tripler performances was really in the hands of most capable scientific investigators and experimenters, and under their direction and by the aid of processes which seem simple enough in the telling, but which require intricate apparatus and precise manipulation under careful supervision to produce the desired results, the production of liquid air now gives the world its working supply of oxygen.

INDUSTRIAL OXYGEN

For the liquefaction of air there are two imperative conditions, the most important being the reduction of temperature. The air *must* be cooled to at least—220 degrees F, that is 220 degrees below zero, not a degree less, and to liquefy the air at this temperature great pressure is required, so the air compressor is the supreme essential for the entire operation. The process crudely consists in compressing air to a high pressure, cooling it as much as possible by ordinary means and then allowing a portion of it to re-expand, this expansion of the air reducing its temperature still more, as had been found in rock drill tunneling experiences. The air thus cooled is used to cool another portion of compressed air, allowing it to expand and become still colder, this process being successively repeated until the air becomes so cold that the liquid air begins to form. It takes a large volume of air for a small quantity of the liquid, the ratio being about 800 to 1, but with sufficient power and continuous operation liquid air is produced in great quantities.

The ordinary air of the atmosphere may be said to be the steam of liquid air. The liquid if not thoroughly heat-insulated boils away very rapidly, the boiling point at normal pressure being 312 degrees below zero, or 524 degrees below the boiling point of water.

THE SEGREGATION OF THE OXYGEN

If the temperature of the liquid air can be so controlled as to allow it to boil away slowly a curious thing occurs, for which we may be thankful. It happens that the boiling points of the two constituent gases of the air, oxygen and nitrogen are more than 20 degrees apart, and so the nitrogen will boil away first and leave the oxygen, which then may be separately collected. The actual process employed, as previously suggested, is extremely complex, but the principle of the operation is here sufficiently indicated. And here we have the source, through compressed air, of the world's supply of oxygen for industrial and other purposes. Oxygen compressed in steel bottles is now common merchandise and procurable everywhere.

The demand for oxygen thus produced is already enormous. Before this war began one producing company in Great Britain with eight plants in the larger cities had an aggregate output of about half a million cubic feet of oxygen per day, and in the United States the business exceeds this several times over both in the number of plants and in the daily output.

REPAIRING THE GERMAN SHIPS

One of the most wonderful results of this ready and plentiful supply of oxygen has been the development and wide employment of the Oxy-Acetylene process, and of other processes closely allied, for the cutting and welding of metals. By this means an intense heat is quickly produced which can be locally concentrated and directed with minute precision, cutting accurately to line when that is required, and with equal facility uniting metals by welding with practically no limits as to the magnitudes involved.

In this line of work the electric arc is equally ready and effective, and these two ready agencies provided a grand surprise for the cunning German tricksters and a most welcome bit of help for American schemes. The final recognition of war conditions by the United States found interned in American harbors a great number of the biggest German liners which had been employed in the Atlantic carrying trade. When war was seen to be inevitable the crews of these vessels had time and clear opportunity to so mutilate the machinery and so disable the ships for service that an incalculable time would be required for their restoration. They seem to have gone to the limits of their ingenuity, but their foresight was defective.

Their mutilating operations were naturally chiefly upon the engines. The favorite trick seems to have been to break a piece out of the main cylinder or other most ponderous and responsible casting, the assumption being that the entire member would have to be removed and replaced, the latter perhaps an impossibility except where the engines were built.

These breakages and other disarrangements merely provided such jobs as the electric arc and the oxy-acetylene jet are constantly aching to get hold of. Under experienced direction all the breakages were quickly repaired in place. Parts broken out were welded into place again. Parts which could not be found were made in the rough, welded into place and then dressed and trimmed accordingly to requirements. The detailed story of these repairs will be choice reading for engineers and mechanics at a later day.

The ships were completely repaired in months instead of years and put immediately into active service. The largest passenger carrying steamers have been making trips which are time records and carrying soldiers now counting up into the millions. These ships have been doing this months and months before the Germans—and even ourselves—could have expected them to be ready.

COMPRESSED AIR RELEASES LAKE STEAMERS

There was another valuable service rendered closely akin to the preceding and aptly illustrating the dual facility of the oxy-acetylene process. A considerable number of big steamers doing business on the Great Lakes were desperately needed for the Atlantic service, but were unavailable because they couldn't get out. They were too long to pass through the canal locks, and that settled it. Compressed air settled it the other way. Oxy-acetylene, the ambidextrous offspring of compressed air, cut the ships in two, and when they had passed the locks and reached tidewater welded them together again as good as new, and immediately ready for the carrying of munitions and supplies.

COMPRESSED AIR BUILDS SHIPS

Perhaps we should speak now of the so-called pneumatic tool and what it is doing. This is an air operated tool closely allied to the rock drill, but differing essentially in the principle of operation, and having a wider variety of adaptation, so that it is now much more numerously employed. It represents and takes the place of the once familiar hammer and chisel of the machinist, its initial typical operation being the chipping of metal. It strikes blows harder than would be struck by hand and at speeds up to a thousand a minute. It is at home with and applicable to all the operations for which the hand hammer has formerly been employed. It is the great riveting tool, the sole reliance now of boiler makers, structural iron workers and shipbuilders for that essential operation. In shipbuilding it is the tool supreme, so essential, and the output of the shipyards so dependent upon and so determined by the speed of its performance, that great rivalry in the making of riveting records has developed in the various shipyards. For the surprising and most gratifying rapidity with which the new ships are being splashed into the water the riveters and other pneumatic tools are to be thanked.

And the story applies now almost equally to the building of the wooden ships as to those of steel. Pneumatic tools are relied upon to do all the boring, the adzing, the planing of surfaces, the calking of the seams, the painting.

COMPRESSED AIR IN THE TRENCHES

Pneumatic tools have developed into successful rivals of the rock drill and have largely supplemented it in its special line of work. The rock drill is heavy in itself, and with its tripod, or the bar, or the column upon which it must be mounted, requires always two men and often three for its proper handling, to say nothing of the time consumed in pulling down and setting up. The hammer drills, as they are called, are one-man drills, easily held. at their work and requiring no waste of time between the completion of one hole and the beginning of the next. They also require not more than one-half the volume of air to keep them going. The fatigue of the single operator also is reduced and these drills have rapidly become the favorites.

It is well known that the trench work in France often involves the cutting of rock, not only in the driving of the open trenches but in the dugouts and passages requiring overhead protection, also in the countermining and tunneling schemes which are a part of the trade of war, and practical miners are always in great demand. Such work may be ordered with great suddenness and must be pushed as if a matter of life or death, which, indeed, it is, and in anticipation of such demands hammer drills by the ten thousand are in the army equipment, with air compressors literally by the thousand in easily portable units and usually gasoline-driven to supply the demand which never ceases.

Where the opposing trenches are near each other, with troops on the alert, the throwing of grenades occurs at every opportunity, and for this service air is not only quick and ready if the supply is constant, but projects the missile with the direction and precision unequaled by any other means. Air horns are in use along the lines capable of shrieking sudden alarms to be heard a mile, and for this also if for nothing else the air must be always ready.

COMPRESSED AIR ON OUR WARSHIPS

Whenever our warships are mentioned we think at once of the big ships and the big guns they carry, forgetting the little ships and the boats that can hardly be called ships at all, but which night and day are on the alert and doing the real active work of the war. This is in no way to belittle the standing menace and terror of the big ships whose mere existence is sufficient to overawe and keep in hiding the great German fleet. But the real active work that tells is being done by the little ships, and in all, big or little, compressed air plays its part. On the big ships it raises the ammunition to the guns and does various lifting jobs and is always ready for the pneumatic tools in engine and boiler room which have frequent employment. It is used for the refrigerating medium, as much safer than ammonia in case of accident. But especially is it the vital agent in the manipulation and equipment of the torpedo.

COMPRESSED AIR SUNK THE LUSITANIA

The mention of the torpedo at once brings us to the U boat as the culminating example of the power and effectiveness of compressed air in the present war. The U boat is simply the elusive conveyor of the torpedo. That is really its sole weapon of offense, and without the torpedo there would be no U boat. The compressed air trick of submergence and reappearance at will is accomplished by mechanical compressions and reexpansions, but those functions are negligible as compared with the action of the torpedo itself when pointed for its prey and scooted out on its course. When released the torpedo is at once entirely a compressed air creature. Air alone drives it on its deadly mission and without the air it would be inert and harmless. Compressed air drove it to smash the hull of the Lusitania, as air has supplied the motive force for its every murderous stroke.

When the U boats began to swarm it rather knocked the breath out of us, and we could not be expected to recover all at once. What emphasized it worst of all was the apparently hopeless onesidedness of it. Submarines could make a big show so easily, for their targets were everywhere, while we, if we had been ever so ready could not have found anything to hit, for German ships had already been swept from the seas.

The records show more and more that the situation is by no means so hopeless, and it is becoming a case of diamond cut diamond, with a heavy preponderance of diamonds for the Allies. If the U boat can destroy by means of the torpedo it can be, and is being, destroyed by the torpedo—compressed air on both sides. We have been late in getting there, but we are onto the job. Not to mention our submarines, whose numbers are not advertised, with our torpedo-equipped destroyers and chasers outnumbering the U boats twenty to one, the game cannot but be a losing one.

And then we have a new compressed air device that is beginning to show what it can do —by doing it. This is the compressed air mortar for throwing the depth bombs. It of course does not operate at long range, but when it gets its chance—and it is instantly ready—it places the bomb in precisely the right spot and gives it the essential drop, nearly vertical, which cannot be accomplished by a gun.

The records of the destruction of submarines are in most instances difficult to verify, for when one disappears it may or it may not be the last of it. We know that the building of submarines has been pushed as the supreme ultimate hope of the Kaiser, and yet their numbers do not increase and their telling strokes become less frequent.

We were speaking above of the onesidedness of the U boat activities. It is a onesidedness of malignity without the suggestion of any mitigating circumstances. The function of compressed air, aside from the U boat torpedo, would seem also to be onesided, but its onesidedness is all beneficient. It helps in all directions, but what is there to help *it?*

It not only is the most indispensable agent in the providing of all the raw materials which come from the rocks, but it is equally helpful in the subsequent processes of manufacture. At the blast furnaces, for instances, which convert the ore to iron or steel, compressors—not blowers—are employed of 50,000 cubic feet per minute capacity or more, while the compressor units at the mines average only 2,000 or 3,000 cubic feet per unit.

A considerable number of compressors are now used at the oil wells simply to deliver large volumes of high pressure air deep down into the wells and largely increase the flow of oil. In the natural gas industry the services of compressors are now of great importance. The value of the annual product of natural gas in the United States, by the way, is more than 25 per cent. greater than that of gold. Where the gas is transmitted for long distances and loses its pressure as it flows, compressor plants are installed to recompress the gas so that it may flow to and be delivered at a much greater distance. Compressors also are largely employed in the compression of gas for the extraction of gasoline, this being now a considerable item of our national supply, and a direct contribution to our war waging resources.

It is the same story all through, as in small things so in the biggest, even to the winning of the great war, compressed air can be only and altogether helpful.

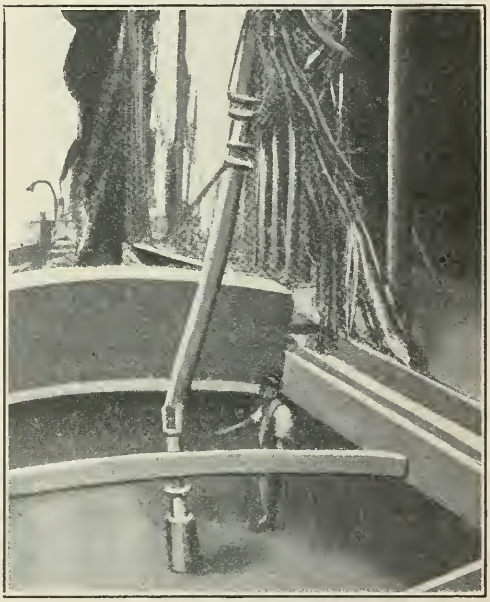


FIG. 1

A PORTABLE PNEUMATIC GRAIN UNLOADER

The apparatus here illustrated is, in the details at least, a development of the war, as it was built to the instruction of the British Office of Works, the illustrations and the description, with some modification, being reproduced from a recent issue of *The Engineer*, London. The principle of operation here employed should be familiar enough to our read-

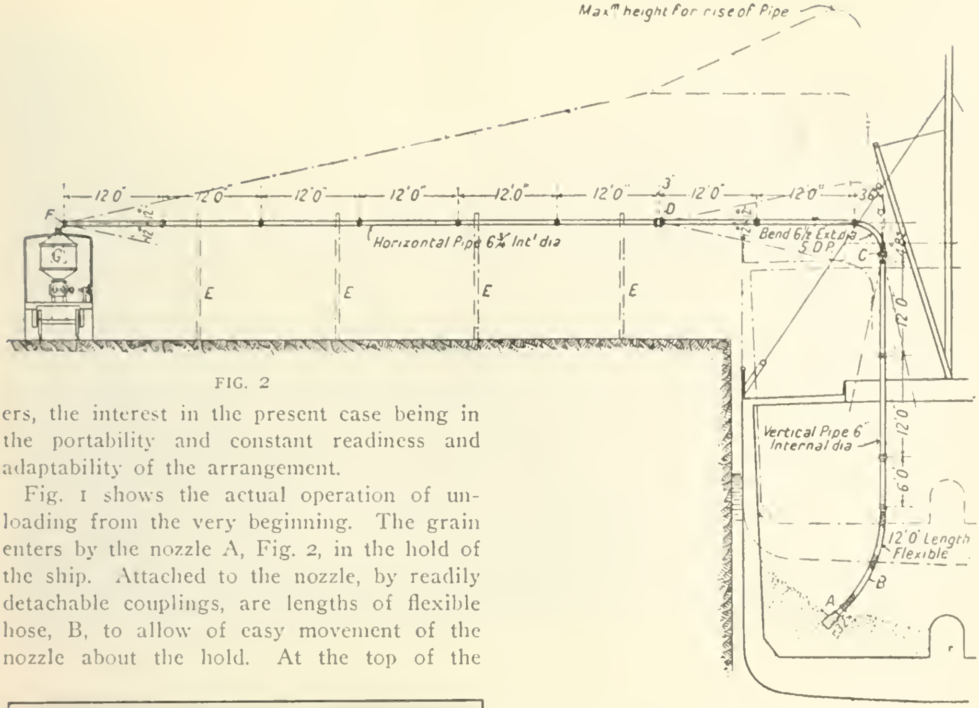


FIG. 2

ers, the interest in the present case being in the portability and constant readiness and adaptability of the arrangement.

Fig. 1 shows the actual operation of unloading from the very beginning. The grain enters by the nozzle A, Fig. 2, in the hold of the ship. Attached to the nozzle, by readily detachable couplings, are lengths of flexible hose, B, to allow of easy movement of the nozzle about the hold. At the top of the vertical portion of the transport line is a ball joint C enabling the whole of this portion of the line to be swung in any direction, thus increasing the surface that may be covered by the nozzle. Adjacent to the edge of the pier, alongside which the ship is moored, is a second ball joint D, the object of which is to allow the end sections of the transport line to be raised or lowered to accommodate varying levels of grain in the hold. The transport line consists of 12 ft. lengths of pipe as shown, joined together by couplings designed to facilitate the work of erection and dismantling. The whole line is supported on trestles E. In order to provide for differences of level between the trucks and the edge of the pier, a third ball joint F is fitted at the near end of the line where it enters the receiving truck. This joint allows the pipe line to be swivelled in a horizontal plane so that the truck need not be exactly opposite to the hold to be unloaded. It will be seen that the whole arrangement provides such adaptability in the transport line that any combination and conditions may be met. Illustrations of a nozzle are given in Fig. 3. The small door shown is opened

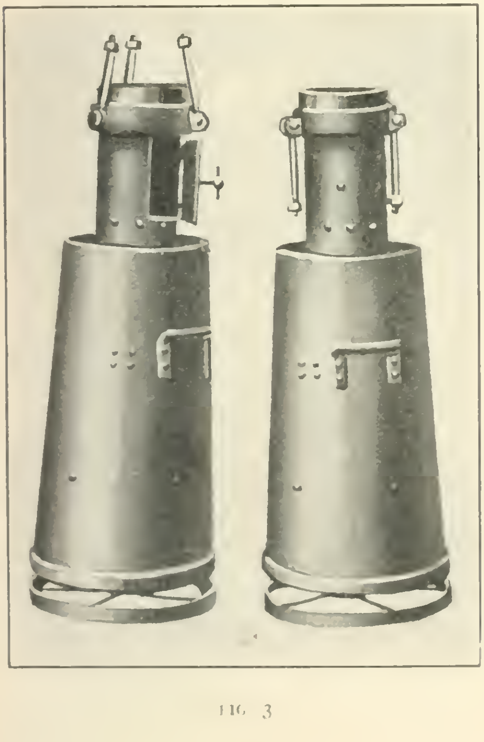


FIG. 3

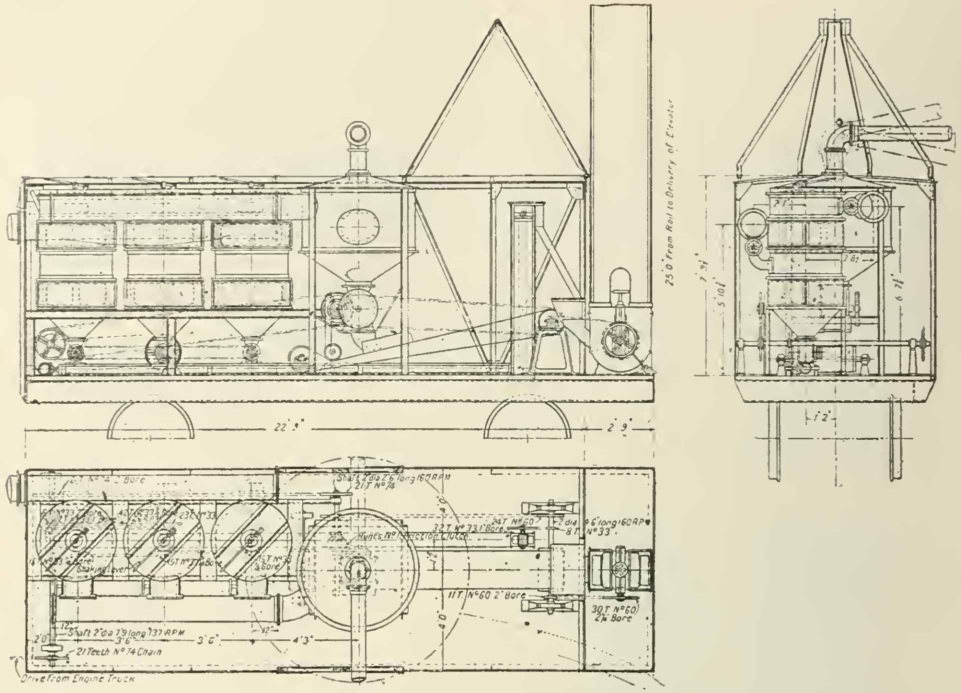


FIG. 4

whenever a block occurs in the pipe, thus admitting air freely above the grain and getting rid of the obstacle.

The grain drawn from the hold enters through the roof of a large receiving chamber on the filter truck, shown in Fig. 4, and by the reproduction of a photograph in Fig. 5. The air moves through this chamber at such a speed that it will no longer carry the grain, which accordingly falls to the bottom, where it enters an apparatus called a discharger, consisting of a bucket-wheel rotating inside a closely fitting casing. Its purpose is to discharge the grain while preventing an inrush of air into the receiver. Thence the grain passes down a shoot to a short band conveyor which delivers it into the boot of the elevator shown at the end of the truck. This elevator is arranged to deliver into the existing weigher trucks at the various docks, when it is automatically weighed and sacked up for delivery. The elevator can be readily dismounted for transportation in ordinary railway wagons. As the bucket wheel is rather liable to become blocked by foreign bodies such as bolts, pieces of wood, etc., becoming jammed between one of the vanes and the casing, a friction clutch is introduced in the drive, which slips in case too much resistance is met with.

The air leaves the receiver by the large horizontal pipe shown to the right of the end view, but not seen in the photograph, and passes to the three filters. These filters consist of a nest of closely woven canvas tubes, through which the air must pass on its passage to the blower. The dust is deposited on the inside of the tubes, which have to be cleaned periodically by a shaking mechanism. Valves are fitted in the inlet and outlet pipe of each filter, enabling any one to be cut off from the rest of the system when it is necessary to shake and clean the tubes. It has been found necessary thus to isolate the filter from the current of air when being cleaned, for otherwise the dust is not removed from the pores of the cloth. By the use of two, or, as here shown, three filters, each fitted with its own valves, it is possible to effect the cleaning without stopping the working of the plant. The dust removed falls into a chamber below the filters and is passed out thence by means of small bucket wheels, and falling into a worm is carried underneath the truck and passed to a small auxiliary elevator which returns it to the grain. It seems an absurd pro-

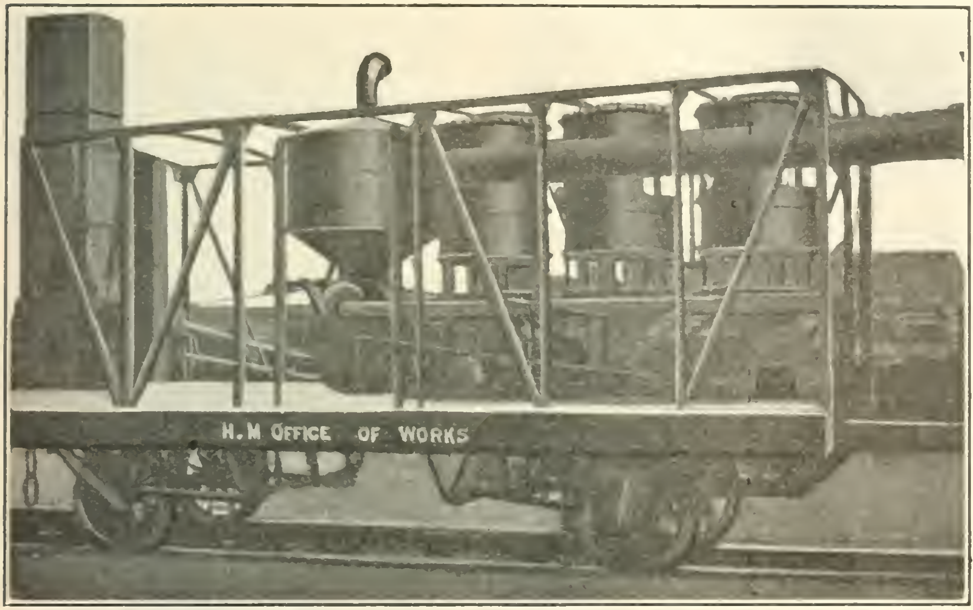

H. M OFFICE OF WORKS

FIG. 5

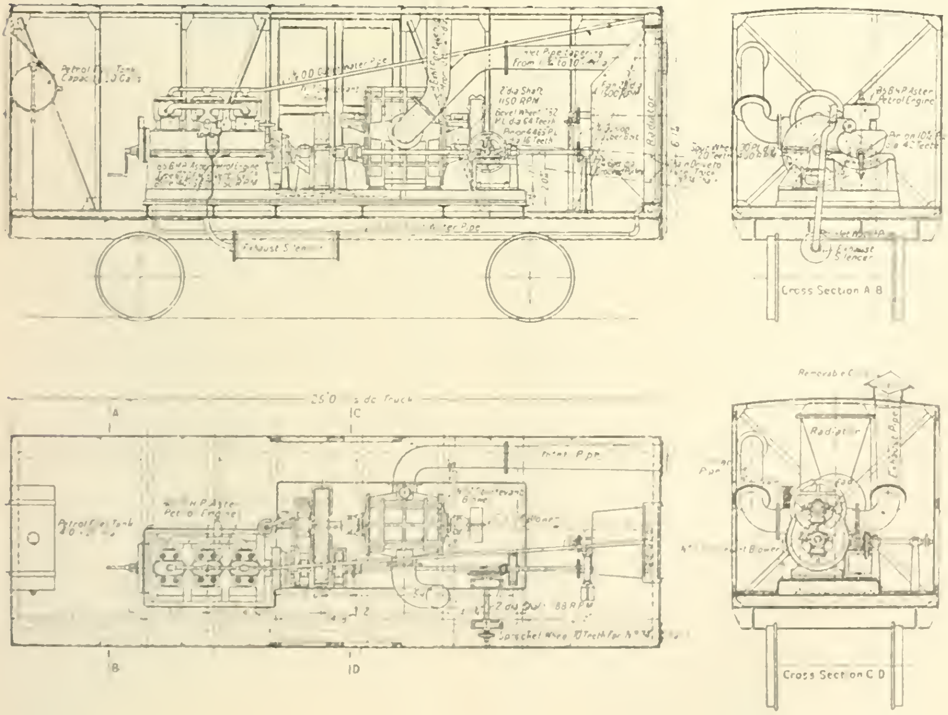

Petrol Tank
2" dia Shaft
1150 RPM
Bevel Wheel
Radiator
Exhaust Silencer
Water Pipe
Inlet Pipe tapering
Cross Section A B
Petrol Engine
Exhaust Silencer
25'0
A
B
C
D
Petrol Fuel Tank
H P Aster Petrol Engine
Blower
Inlet Pipe
88 R P M
Sprocket Wheel
Removable Cap
Radiator
Fan
Exhaust Pipe
Blower
Cross Section C D

FIG. 6

cedure to cleanse the grain and then foul it again, yet merchants require that the dust separated shall be returned in order to check their shipping weights.

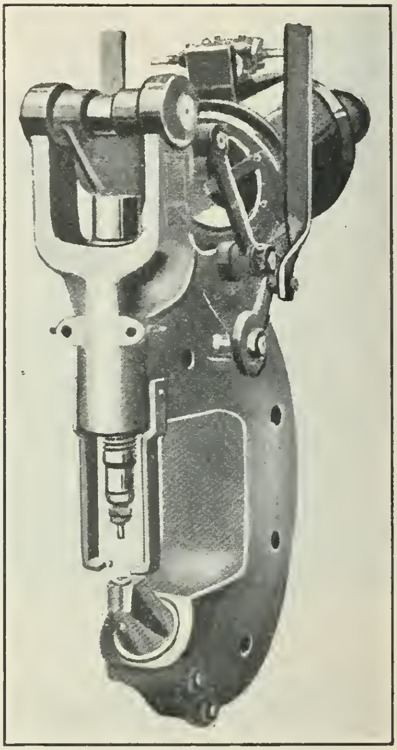
The air, freed from dust, passes from the first truck to the second by the pipe seen in Fig. 5. This pipe has a flexible connection in order to accommodate varying lengths between the two trucks, and also to avoid damage from shock, say during shunting, and to allow the trucks to stand on a curve.

The second truck is also shown in Fig. 6. The rotary blower which exhausts the air is driven by an 85 horse-power Aster engine, through spur gears, enclosed in a gear case with an oil bath. Countershafts, driven by gears, with a chain connection between the two trucks provide the motive power for driving the grain discharger, the three dust bucket wheels, the dust worm, the band conveyor and the two elevators.

The official trial was conducted at Ipswich, when, by courtesy of Canfield, Limited, a cargo of wheat was discharged from the hold of an eighty-ton barge into a receiving elevator of their mill.

The barge lay alongside the pier at a distance of 100 ft. from the elevator, the portable horizontal transport line being carried along the columns on the pier side, about 20 ft. above the grain in the hold. The plant was started up for a short preliminary run to effect adjustments necessitated by the class of grain to be handled; the capacity averaging 23 tons per hour and ran up to 32 tons per hour, at which point the plant was stopped. After an interval the trial proper was run, the average and maximum capacities attained being 27 and 33 tons per hour respectively—the guaranteed capacity, at the maximum distance of 100 ft., being 25 tons per hour. The area of the hold being great in proportion to the depth, made it unfavorable for obtaining a higher average. An excessive amount of dust also was present.

SHIPYARD RIVETING AND PUNCHING MACHINE



PNEUMATIC PUNCH AND RIVETER

The illustration on this page shows a riveting and punching machine of special type which has been designed for shipyard use by the Hanna Engineering Works, 1765 Elston Avenue, Chicago. It may be remarked that the machine is heavier and more powerful than a casual glance at the picture might suggest. In addition to driving rivets 1 in. in diameter with a single stroke of the air piston the machine also can drive a punch which will cut holes of the same diameter in ⅝ in. steel.

The machine follows the builder's standard type of construction for riveting machines and uses a combination toggle and lever action which is relied upon to upset the rivet completely in the hole, thus forming a tight head and following the shrinkage of the rivet with the full rated pressure of the machine until a set is secured. The toggle action, it is explained, builds up the pressure at the dies during the first half of the piston stroke and then merges into a combination toggle and lever action which is relied upon to maintain the toggle alignment and pressure while the die travels through the final half of the stroke.

To facilitate the punching operation a dash-pot mechanism is provided which takes up the forward thrust of the plunger when the punch shears through the material. A forged steel nose or lower stake which can be readily removed by loosening the set screw holding it in place is provided. This nose is relied upon to enable the operator to work in very close sections such as bulb angles and bent ship channels. The machine being normally used in suspension the pivots of the sling are so located that the machine is balanced and can be inclined to any angle the work may require.

NITROGEN FROM THE ATMOSPHERE

The largest experimental plant in the United States for the manufacture of fixed nitrogen from the air, with the exception of the ones now being constructed for the War Department is in operation at the Unietd States Department of Agriculture Experiment Farm, Arlington, Va. At this plant the nitrogen from the air is combined with hydrogen to form ammonia which can be used in the manufacture of explosives and fertilizer. Experiments are now being conducted at this plant by the Bureau of Soils with a view to increase the efficiency of the process. The War Department is co-operating in this work. What is known as the Haber process of nitrogen fixation is being used. This process involves the production of ammonia from hydrogen and nitrogen. The two gases are mixed in the proper proportions, put under high pressure, subjected to intense heat and passed over spongy iron, whereupon a portion of the mixture combines to form ammonia.

GERMANY'S DESPERATE ACTIVITY

The output of ammonia by the fixation of nitrogen from the air has grown to very large proportions in Germany since the war started. According to the London *Iron and Coal Trades Review*, the production of ammonia in Germany by the Haber synthetic process, according to a German daily paper, rose from 30,000 tons in 1913, to 60,000 tons in 1914, to 150,000 tons in 1915, and 300,000 tons (estimated) in 1916. An output of 500,000 tons of ammonia was anticipated in 1917, containing 100,000 tons of nitrogen; at the same time 700,000 tons of sulphate of ammonia (140,000 tons of nitrogen), and 400,000 tons of calcium nitrate (80,000 tons of nitrogen) was expected to be produced, the total containing 320,000 tons of nitrogen, which exceeds by 100.000 tons the entire consumption of nitrogen in Germany in 1913.

FUNCTION OF AIR IN COMBUSTION

A bunsen burner can be used to show how mixing air with a flame affects combustion. When the air supply is turned off the flame from a bunsen burner is luminous. Its luminosity is due to incandescent particles of solid carbon resulting from the decomposition of hydrocarbons in the gas. The interior of the flame contains no oxygen to burn the hydrocarbons, and they are decomposed by heat into hydrogen and carbon. When the air is mixed with the gas as it enters the burner, the flame is nonluminous and has a well-defined inner cone. In this inner cone the oxygen of the air combines with hydrocarbons of the gas, producing H_2 and CO, which burn on the outer envelope of the flame. The reactions in the presence of oxygen produce gases that are easily burned, whereas the carbon produced in the absence of air is difficult to burn. Similarly, air mixed with volatile matter in the furnace before the tar is decomposed by heat may produce a larger proportion of combustible in the form of gas and less in the form of carbon.—*Bureau of Mines Bulletin No.* 135.

HIGH SPEED RIVETING RECORDS

The following from *Engineering Fleet News* we must accept without question. Two riveting gangs at the shipyard of the Groton Iron Works, Groton, Conn., recently made five-day averages of 1,202 and 1,138 rivets per day. The work was of difficult character, being on oil-tight outer bottom work, ⅞-in. pan-head countersunk-point rivets. Each gang consisted of riveters, holder-on, passer and heater. Working nine hours per day, one gang made daily records varying from 1,185 to 1,241 rivets, while the other drove from 1,058 to 1,181 rivets per day. Not one of the rivets was cut out.

WHY WOULDN'T THE ZEPPELIN BE A FAILURE?

Aluminum in the framework of a modern German zeppelin, according to notes furnished to a London journal by a French officer, is used to the extent of 10 to 12 tons. This seems an enormous bulk, as the metal is so light. The covering of the 18 balloons enclosed inside the big outer envelope is made of a cotton substance, lined with "goldbeater's skin," instead of with rubber, and the quantity used is so large that the intestines of 30,000 cattle go into the material for one zeppelin. Each of the 18 balloons is fitted with a valve, and separated from those on each side of it by a funnel to carry off the explosive mixture of the hydrogen of the balloons, the oxygen of the air, and the gases given off by the engines. When all five motors are working together, one contained in the forward car, one in each of the two side cars, and two in the rear car, the speed attained is 68 miles per hour, but, as a rule, all the engines are not used at one time, and the normal rate of flight is from 50 to 56 miles per hour. The ordinary crew consists of 22 men.

LIQUID OXYGEN EXPLOSIVES IN GERMANY

Le Genie Civil describes some recent German developments in the use of liquid air for blasting. The Sprengluft Gesellschaft m.b.H. manufacturers plants capable of supplying 22 lb. of rectified liquid oxygen ("oxyliquite") per hour, at a net cost of less than two cents per lb. The liquid oxygen is stored in a modified form of Dewar flask, usually of brass or thin steel, the jacket space being filled with charcoal, which absorbs any small amount of gas escaping through the pores of the metal. In utilizing the liquid oxygen for blasting, lampblack has been found the most satisfactory combustible material. Cartridge cases of cardboard are filled with the lampblack, and then immersed for some time in a tank containing the liquid oxygen, so that they become thoroughly impregnated just before use. They are usually fired by a small primer, preferably ignited by electricity. Oxyliquite is stated to be very efficient for mining, but is less suitable for quarry work. It is considered safer than the explosives generally used, since the cartridge is only explosive for ten minutes after the time of saturation with the liquid oxygen. This fact, however, makes it necessary to instal a liquid oxygen plant near the scene of operations.

THE MAN BEHIND THE MAN BEHIND THE GUN

By Marie Randall

I can't fight in the trenches 'cause my hair is gettin' gray,
And they say my days of work are nearly done;
But there's one thing that I'm proud of, and I say it every day,
I'm the man behind the man behind the gun.

Sometimes I'm feelin' mournful-like because I'm gettin' old
And younger lads are havin' all the fun;
But I keep a-working steady for I want to have it told
I'm the man behind the man behind the gun.

When trouble starts a-coming in the front line over there;
When our lads are gettin' hustled by the Hun;
We want 'em to be mighty sure the game is on the square
With the man behind the man behind the gun.

The boys will win the victory and make us mighty glad—
Sure, and one of them may be my only son.
I want him to come back and say "You helped us do it, dad;
You're the man behind the man behind the gun."

—*American Machinist.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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THE UNIQUE OPPORTUNITY

When these lines first greet the reader's eye the subscribing to the Fourth Liberty Loan will be in full swing, and our belated word must be of small account. These are the days when world records are being made in all fields, not only in the magnitude of the things which must be done but also in the magnificence of their accomplishment, and now it is upon us to make another record in keeping with the rest.

Not often do so many overwhelming considerations so imperatively urge to the doing of a thing as here and now, but the things which each must do vary incommensurably. First is the automatic call for the fighting men, and as it sounds they everywhere are dropping everything to respond. Some must give their life, and some their health and some their worldly prospects for the future, and none can say what else were right for them.

The other call, not more to be ignored nor less imperative, is for vast sums of money. It calls upon us all, and it calls not for what we have not. The call is neither to pay nor to give. The call is simply for investment without speculation, investment in the strongest savings bank in the world with full savings bank interest. We all know that these things are so, and that is all sufficient.

THE AMERICAN RIVETING ADVANTAGE

We print on another page of our present issue a rather astonishing account of the status of the pneumatic riveter in British shipyards, the matter being presented with such authority and precision of statement that it cannot be questioned. It is not easy to account for this lack of appreciation, and consequent insufficiency of employment of the pneumatic tool in this important field. It surely is not for lack of information on the uses of compressed air. It is a curious fact that in some of the larger and older of the British shipyards, as for instance that of Harland & Wolff—which, however, is in Ireland—compressed air is employed more numerously than in the United States for operating the large forging hammers which normally have been driven by steam.

The Engineer shows by actual figures that the pneumatic riveter does more work in any given time than the hand riveter and that it does it with fewer men per gang. It should have mentioned also the additional fact of importance that the handling of the pneumatic riveter does not demand the practiced skill or the slowly acquired manual facility of the hand riveter. It takes years to develop a high class riveter while hours, or days at the most, are sufficient for an average man to learn all the manipulation of the air driven tool. The pneumatic riveter, moreover, does perfect work at once and does not require to be employed upon low class work until it gets its hand broken in. There is apparently no superiority of any kind to be claimed for hand riveting, unless it might be a certain picturesqueness resulting in the lack of absolute uniformity in the individual rivets.

It does not appear how much the prejudices and habits of the British workman may operate to retard the use of the pneumatic riveter, but probably this has no weight in the matter. It is rather a case of national inertia, and we have a curious corrobative instance of this in another article also to be found in our present issue. In this is reproduced a photo of a lot of women who have taken the places of men with pick and shovel and wheelbarrow for an extensive job of earth excavation. Why, with us in these days it would be impossible to find even men employed on such a piece of work as this, because we always do it with a steam shovel.

The universal adoption of the pneumatic riveter in shipbuilding, boiler making and other work to which it is adapted seems to be indisputably an industrial advantage for us, but we are not forgetting that there are other advantages which still prevail on the other side of the Atlantic, as is sufficiently evidenced by cheap and prolific production in many lines, and not least among the results of universal good which shall come out of the great shaking up of the nations must be not only mutual respect and appreciation but a greater familiarity with each other's means and methods, a general abandonment of the slow and worthless ways, and a reciprocal adoption of what is best, for the advantage of all.

A CORRECTION

In our August issue, page 8848-9, we reprinted from *Coal Age* a carefully prepared statement of the conditions necessary to be observed for the successful installation and operation of mine siphons. We regret that an unfortunate error occurred in the reprinting of a responsible formula which occurred in the formula. We reprint the formula below, calling attention to the last number of it, with below it the same number properly corrected.

$$(H - h_1)\frac{d_1^5}{l_1} = (h_2 - H)\frac{d_2^5}{l_2}; \text{ and } d_1 =$$

$$d_2^5\sqrt{\frac{(h_2 - H)l_1}{(H - h_1)l_2}}$$

$$d_2\sqrt[5]{\frac{(h_2 - H)l_1}{(H - h_1)l_2}}$$

THE ENDLESS ROAD OF INVENTION AND DISCOVERY

The following occurs in an address by E. W. Rice, Jr., President of the General Electric Company, to a graduating class of students:

I have been engaged in engineering work, mainly electrical, for nearly forty years, during which time the entire electrical industry may literally be said to have had its birth and development—the telephone, electric light, electric motor, trolley cars, wireless telegraphy, wireless telephone, electric transmission of power—all these have appeared since my first youthful venture in electrical work.

Now on a number of occasions, during these forty years, a lull in new inventions and discoveries seemed to have come about; and on such occasions I have talked with eminent engineers and inventors who all agreed that there was nothing more of importance in our line to be discovered. This conviction was strongest about thirty years ago; fairly strong about twenty years ago; a little weakened but still existing fifteen years ago, but now is a dead doctrine. I have had no such discussion for over ten years and do not expect to have another so long as I live, for facts have been against that theory, and of course facts are such stubborn things that theory which contradicts facts must be abandoned.

The first steel ship built without rivets, so far as known, has just been launched on the south cost of England. The plates were fused together by electric welding in one process. General adoption of this process, it is held, would effect a saving of from 20 to 25 per cent. in both time and material.

NEGLECT OF PNEUMATIC RIVETING IN BRITISH SHIPYARDS

The following which we reprint from a recent issue of *The Engineer*, London, deserves careful reading, although the readers most to be benefited are not in the United States.

It is common knowledge, the writer says, that the rate of out put of merchant shipping falls far short of what is necessary and possible. Even if the two most obvious causes of this, viz., shortage of skilled labour and bad time-keeping, loss of time by the workman, were removed, the output would still remain far below what is easily possible. One of the principal reasons for this is simply that British shipyards make very little use of pneumatic tools. To what extent the capacity of shipyards may be affected by the use of pneumatic riveting instead of hand riveting, the following figures will show.

HAND RIVETING AND PNEUMATIC COMPARED

According to information recently received from one of the leading East Coast shipyards, the best day's work on a shell with pneumatic riveting is 700 rivets of seven-eighths of an inch diameter, and for hand work, under the same conditions, 430 rivets. An average day's work, however, is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters against 264 with a hand squad, the figures being taken for work on all parts of one ship. The number of rivets driven per day by a riveting squad varies, of course, according to the part of the ship worked upon and the size of rivet used. The following may be taken as indicating the difference in one day's work of a hand and pneumatic riveting squad:—On the shell, with $\frac{7}{8}$-in. rivets, hand riveting, 260 to 300 rivets, with pneumatic riveting, 500 to 550; on the deck, with $\frac{5}{8}$-in. rivets, hand riveting, 450, pneumatic 700; on the deck, with $\frac{3}{4}$-in. and $\frac{7}{8}$-in. rivets, hand riveting 350, pneumatic 550.

PNEUMATIC RIVETING TAKES FEWER MEN

The greatly increased output of work secured by the pneumatic tool is in itself sufficient to establish its very considerable superiority over the hand method. But it has another very important advantage. A hand-riveting squad consists of three men and one or two boys. From two of these squads, three pneumatic riveting squads can be formed, thus effecting a saving of 50 per cent in labour alone. A third advantage claimed for the pneumatic tool is that it gives both the other advantages with less exertion and consequently less fatigue on the part of the men.

ACTUAL FIGURES FROM BRITISH YARDS

With these advantages to its credit, it is, nevertheless, the fact that the pneumatic tool is greatly neglected in British shipyards, as the following facts and figures, taken from the returns of 70 of the leading yards of the country, will show. Only yards having berths of over 250 ft. in length are taken. It may be said in passing, that the equipment necessary for the efficient working of a berth is generally considered to consist of a compressor plant of 1000 cubic feet per minute capacity, to supply the compressed air for driving the tools, and 60 pneumatic tools, of which 20 should be riveting hammers. Taking the ten best-equipped yards in the country, they have, as a rule, compressor plants of 1000 cubic feet per minute per berth, but only 52 pneumatic tools, of which only $1\frac{1}{2}$—on the average—instead of 20 are riveting hammers. The average of the remaining 60 yards is much below even this standard. It shows only 21 tools per berth and 333 cubic feet per minute compressor capacity per berth. Moreover, only about one-eighth of the number of riveting hammers in stock in the yards are actually used. Then again, there are 22 important yards in the country, with a total of 77 berths, which have no pneumatic plant whatever.

THE NATURAL CONSEQUENCES

Shortage of riveters is, beyond question, one of the chief causes, or the chief cause of deficient output at the present moment. This shortage is no new thing in the British yards where for the last eight or ten years the supply of riveters has fallen short of the demand. War and other causes have further reduced their number, while the volume of work has been increased. The serious effect of this state of affairs on the output of ships must be obvious. In some yards, ships completely plated cannot be launched because they cannot be riveted. The solution of the problem is to be found to a very great extent in the greatest possible use of the pneumatic tool. The United States yards, by their almost universal employment of pneumatic riveting tools, have been able to overcome their shortage of skilled labour.

ABOUT GASOLINE

By Augustus H. Gill

The term gasoline was formerly applied to the higher portion obtained by distilling crude petroleum, more particularly that above 80 deg. Baumé (pronounced bomay). The name means "like gas" and is derived similarly to "butterine" and other words of like ending.

Owing to the present great demand for gasoline, anything lighter than kerosene (45 deg. Baumé), and even some of that, finds its way into the commercial article, which then becomes really naptha, an intermediate product. This designation "deg. Baumé" refers to degrees on the hydrometer devised by Baumé for measuring the densities of liquids lighter than water. It is a weighted glass spindle which sinks to a greater or less depth in a liquid, according as it is light or heavy. Thus in water it sinks but 10 deg., in engine oil to 25 deg., in kerosene to 45 deg., in motor gasoline to 60 deg. and in illuminating gasoline to 86 deg. These are spoken of as "86-deg. gasoline," etc. But this designation refers simply to the weight of the liquid, or "gravity" as the oil man says, and it has nothing to do with boiling point, freezing point or percentage composition; it is simply a commercial way of naming the different grades. To a certain extent, however, it is a measure of the volatility, or ease with which it is converted into vapor, for the higher the number or "test" the more readily is the gasoline changed into vapor. While this "gravity" or hydrometer test is the one commonly employed, it is a very unsatisfactory and unreliable test, as mixtures can be made which will have the same gravity and yet one will be very unsatisfactory; for example, a mixture of equal parts of 56 and 86 deg. and one of 25 per cent. each of 56, 66, 76 and 86 deg. will have the same gravity (71 deg.), and yet the latter will work much better than the former, which will vaporize irregularly and tend to make an engine run unevenly. This extremity of mixture would be revealed in a distillation test that consists in boiling the gasoline, condensing the vapor to a liquid and noting the quantities that come over at the different boiling temperatures. In the gasoline made up equally of an 86- and 56-deg. mixture the quantity of low-boiling and of high-boiling distillate would run nearly even in volume.

Gasoline is made in three different ways: First, by distilling crude petroleum on a large scale, as is done on a small scale in the distillation test just described; second, by "cracking" the heavy oils, engine oils, etc., by great heat and pressure (Rittman and other processes); third, by causing natural gas under pressure to pass through cooled tubes when the gasoline vapors it contains are chilled out of it (this is called "casing-head" gasoline).

While gasoline ignites at 1400 deg. F., a dull-red heat, it cannot be ignited by a soldering copper, a cigar or cigarette, but woe to the man who uses a blowtorch or lights a match in the proximity of gasoline vapor. The temperature of these flames is about 2100 deg. F., therefore much above the ignition point of gasoline. In use it is ignited by a voltaic or dynamic spark but the fact must not be overlooked that it can also be fired by frictional electricity. One of the earliest accidents of record caused by frictional electricity was the "hair-dresser's accident" in 1897. A woman was being shampooed with a wash containing gasoline when sufficient frictional electricity was generated to produce a spark which ignited the vapor, burning her so severely that she died. A naval surgeon wearing a fur coat and rubber boots (which insulated him from the ground) made a spark, presumably by friction on the fur, sufficient to ignite the gasoline in the tank of an automobile. Sparks of considerable intensity are not infrequently generated from furs. Gasoline is electrified by passing through chamois skin or a rubber hose. Automobiles have been set on fire by a spark from a chamois-lined funnel used in filling the tank, and perhaps insulated from it by a wooden block or from a hose through which gasoline is pumped when the cock on the end did not touch the tank. The chamois should be replaced by 80- to 100-mesh brass gauze, and the hose and cock should be grounded by a chain connecting them with the metal storage tank. In filling cans, for example, they should be connected with the gasoline pump by a chain or wire because sometimes the friction of the gasoline in the pipes makes electricity enough to cause a spark to jump from the pump to the can, firing the gasoline.

In handling gasoline it should be remembered that the vapor is heavier than air (3.5 times) and settles. It flows like a stream and has been known to run in a stratum and become ignited from a boiler fire 60 ft. away. Gasoline does not explode except in a confined space; the explosive range, that is, the percentage necessary to make air explosive, is between 1.5 and 6. In other words, an air mixture containing one and one-half to six volumes of the vapor in one hundred is explosive. Putting it another way, two quarts of gasoline, if diffused through a room 10x10x10 ft., would make a first-rate explosion. This is equal to about 5 tablespoonfuls in a 5-gal. can. The following table shows the number of cubic feet of vapor produced by different quantities of gasoline:

Liquid Gasoline.	Gasoline Vapor. Cu.Ft.
128 liquid oz. (1 gal.)	32
64 liquid oz. (2 qt.)	16
32 liquid oz. (1 qt.)	8
8 liquid oz. (½ pt.)	2
4 liquid oz. (1 gill)	1
½ liquid oz.	⅛ (App. 1 gal.)

One volume of the liquid becomes 240 volumes in the vaporous condition.

The heating value of gasoline varies from about 17,860 B.t.u. (for 62 deg. Baumé) to about 18,080 B.t.u. (for 76 deg. Baumé) per pound, or 109,024 and 102,152 B.t.u. per gallon respectively; that is, the heavier gasoline has the greater heating value per gallon and less per pound.—*Power.*

TRANSVAAL POWER PLANT DATA

The Victoria Falls and Transvaal Power Company is the largest power undertaking in the Briitsh Empire. Approximately 837,000,000 units (kilowatt hours), or 1,120,000,000 h. p. hours were sent out of the generating stations in the year 1917. This involved burning over 1,000,000 tons of coal, a large proportion of which consists of duff, and is a bye-product from the collieries. The year's operations involved the heating and evaporating into steam of about 6,500,000 tons of water and this quantity was passed through the turbines and condensed in the surface condensers, which required the circulation of approximately 78,000,000,000 gallons of water. The total number of units sold for lighting, power and tramways by the Public Utility Companies and Municipalities of Greater London for the year 1916 was approximately 450,000,000 units, or about 40 per cent. less than the units sold by the Victoria Falls and Transvaal Power Co., Ltd., to the mining industry on the Witwatersrand.

COMPRESSED AIR BY THE TON

The compressed air supply is much the largest in the world. During the year 1917 no less than 2,000,000 tons of air passed through the main pipe network from the two compressor stations to the mines for use in driving rock drills, etc. At the time of maximum load each day air is delivered at the rate of about nine tons per minute. Approximately 20,000,000 tons of air were passed through the boiler furnaces and up the smoke stacks in the year 1917.

SUBMARINE MINES

Generally speaking, there are two types of mines: fixed and floating. The fixed or stationary mine is fired by contact, electricity, timing device or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by submarines and other specially equipped mine-laying vessels. Such a mine is provided with an anchoring device and is deposited, if possible, in harbors and channels of the enemy or in the path of ocean travel.

Floating mines differ from fixed mines in that they are unanchored, and unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must be, according to the laws of war, designed to become inoperative within a few hours after being set adrift.

The German floating mines are often cast adrift in pairs, connected by a line about 100 feet long. If a ship runs between the two mines, they are drawn alongside the ship and exploded.

Many proposals have been received suggesting the use of a contact depth mine which will rise to the surface if floating to contact. This type, however, is considered unnecessary and inadvisable. The essence of the depth charge is that it explodes in the vicinity of the submarine, in case it fails to strike the boat itself. The use of the contact depth mine presupposes the necessary accuracy to strike the target. The recovery feature is of no particular value, and would necessitate numerous safety precautions to ensure absolute safety in picking up. *Bulletin No. 2, Naval Consulting Board.*

PARIS GREEN—POTATOES—AIRPLANES

The means by which the Nation's supply of Paris green escaped serious curtailment is announced by the Food Administration.

The supply of acetic acid, heretofore considered indispensable in the manufacture of Paris green, was taken over some months ago for the manufacture of airplane "dope," the material used for making the cloth on airplane wings weatherproof.

In co-operation with the War Industries Board, the chemical experts of the Food Administration called a trade conference at which the situation was outlined and plans solicited to solve the acetic acid shortage. By arrangement with large yeast manufacturers, vinegar, which contains about 10 per cent. acetic acid, is now being supplied manufacturers of Paris green, of which an adequate supply—at least, normal—is now assured. Department of Agriculture experts advise also that lead arsenate and calcium arsenate, which are cheaper (especially the latter), can be used as an equivalent substitute for Paris green in many cases.

It is striking that the acetic acid which formerly went into Paris green with which farmers fought the ravages of insects is now contributing to the efficiency of airplanes with which American boys are raining destruction on the Nation's greatest enemy, the Hun. Although technical experts have protected agriculture against a shortage of Paris green, this case is typical of commercial readjustments which may from time to time be necessary.

NOTES

The Royal Air Force has issued a statement showing the enemy losses in aircraft as compared with Allied machines missing from July 1, 1917, to June 30, 1918, on the Western front and during shorter periods on other fronts. The total number of enemy machines destroyed is 2,985; of enemy machines driven down, 1,117; of Allied machines missing, 1,213.

Gas is to be used exclusively for rivet heating, plate bending and general fabricating heating purposes hereafter at the Bethlehem Shipbuilding Corporation's Alameda plant. This is a radical departure from the shipbuilding methods that have been in use for years, whereby it was thought that only coke could be used—even oil was considered an innovation.

The flash point of an oil is the lowest temperature at which the vapors arising therefrom ignite without setting fire to the oil itself when a small test flame is quickly approached near its surface in a test cup and quickly removed. The flash point of lubricating oil is higher than the boiling point, while that of alcohol, benzine, kerosene, etc., is lower.

The "salting" of wooden ships at the shipyards of the Foundation Co. at Portland, Ore., is being facilitated by the use of an air jet. Salt is placed between the ceiling and planking of all wooden ships as a wood preservative. Ordinarily the process delays the planking. Under the method followed by the Foundation Co. a hole is bored through the ceiling and the salt blown into place by means of the air jet.

Of 47,243 soldiers in the United States Army training detachments being given vocational training for overseas service, 17,429 are being taught auto mechanics, 5,450 auto driving, 2,137 blacksmithing, 4,506 carpentry, 2,969 electricians, 1,251 gas engine, 1,130 general mechanics, 2,054 machinists, 3,724 radio operation, and 996 sheet metal work. The other work varies from that of wheelwrights to cobblers and locomotive engineers.

Tunnel connection of Denmark and Sweden has recently been proposed, with a view to carrying electric railway traffic across the strait. According to a note in the *Schweizerische Bauzeitung,* the location selected extends from the island Amager, near Copenhagen, Denmark, to the island Saltholm and thence to Lunhamn, near Malmö, Sweden. The line is 22 miles long, including tunnel and surface portions. Its cost has been estimated at $25,000,000.

Two royal air force officers, with two mechanics, recently completed a flight from England to Egypt, a distance of 2,000 miles, in a type of airplane that has seen considerable service on the front. The official report in announcing this feat, says: "One or two halts were made for petrol, but the flight was merely a bit of routine work."

In England for the heavy chucks used with large power-operated lathes instead of relying upon manual power to close and open the chuck compressed air is largely used. This saves the women's energy, in fact, making possible work that probably could not otherwise be done by them, reduces time of setting up and taking down the job, and thus speeds up production. It is claimed that the use of compressed air in this way increases production from 20 to 100 per cent.

Representatives of manufacturers of power-driven portable vacuum cleaners have agreed with the Conservation Division of the War Industries Board to reduce their lines to not more than two models or sizes, to discontinue the manufacture of less essential attachments and discontinue use of metals where not absolutely essential. These plans will result in an annual saving at least 100 tons of steel, 5 tons of brass, 125 tons of aluminum and 1,000,000 ft. of rubber hose.

The record for holes punched singly in 10 hours has been broken by the Ferguson Steel & Iron Co. of Buffalo, which is fabricating and assembling 16 steel barges for the United States Railroad Administration. A. Rostowicy, expert puncher for the Ferguson company, punched 18,624 holes in 10 hours, most of the holes being about 4 in. apart. This breaks the record held by Charles Milburn of Chicago, who several years ago punched 18,310 holes in 10 hours.

One of the mechanical wonders of the war is the moving bakery used by the British. This is a portable machine capable of mixing the flour into dough, molding the dough and dividing it into predetermined weights. The machine is mounted on a specially constructed motor truck so that it can follow the troops. With a crew of five men it will make 6,000 loaves of any size, shape, or weight in one hour. This is the same amount of work which formerly required 112 army bakers mixing bread in the field by hand.

The new Liberty plant of the Bethlehem Shipbuilding Corporation at Alameda, Cal., will be twice the size of the Victory plant of the Bethlehem Shipbuilding Corporation at Squantum, Mass., and will involve twice the expenditure. The plant, which will have 10 shipways, will cover more than a third of a square mile and from 3,000,000 to 4,000,000 yds. of dredging will be necessary. Large vessels will be constructed, contracts for which have already been awarded by the United States Shipping Board.

A series of tests with stenches as a warning for miners is being made by the Bureau of Mines. A liquid chemical is injected into the compressed-air line at the engine room. The vapor thus is carried quickly to the farthest opening of the line. About five minutes are required for the warning to be received at a punching machine which is approximately 1800 ft. from the compressor. The odor soon diffuses to all near-by parts of the mine, and is carried along by the ventilating current. The laboratory work in this connection is being done in the gas section under the direction of Lieutenant Katz. The most disagreeable nontoxic odors obtainable are being tried.

Four engineers have been named by the fuel administration to undertake savings in power plant fuel consumption. These are Thomas R. Brown, Pittsburgh, formerly special engineer with the Westinghouse Air Brake Co., for the western half of Pennsylvania; George R. Henderson, Philadelphia, formerly consulting engineer with the Baldwin Locomotive Works, for the eastern half of Pennsylvania; Edward N. Trump, New York, vice president of the Solvay Process Co., for New York state; and W. R. C. Carson, Hartford, a consulting engineer, for New England. The principal question under consideration is the waste of coal in the 250,000 industrial power plants of the country.

Germany has conquered Belgium, Poland, Serbia, Lithuania, Courland and Frinli. But the Allies have conquered cotton, wool, jute, leather, rubber, copper and feeding-stuffs.

LATEST U. S. PATENTS

JULY 9

1,271,544. VACUUM MILKING-MACHINE. Claude Hudson Davis, Wanganui, New Zealand.

1,271,545. GRAIN-CLEANER. Monroe Davis, Enid, Okla.

1,271,562. AIR-PUMP CHECK. Robert A. Gally, Cincinnati, Ohio.

1,271,712. UTILIZING AN EXPANSIVE FORCE. Herbert Alfred Humphrey, London, and William Joseph Rusdell, Dudley, England.

1. The method of speed control of a fluid motor operating under varying fluid velocities, which consists in producing one force which is a function of the speed of such motor, another force which is a function of the torque thereof, and in balancing said forces against each other and regulating the load on the fluid motor in accordance with the point of balance, so that the motor is maintained at a predetermined speed for each fluid velocity.

1,271,956. AUTOMATIC LIQUID-ELEVATOR. William Hurley Smith, Deming, N. Mex.

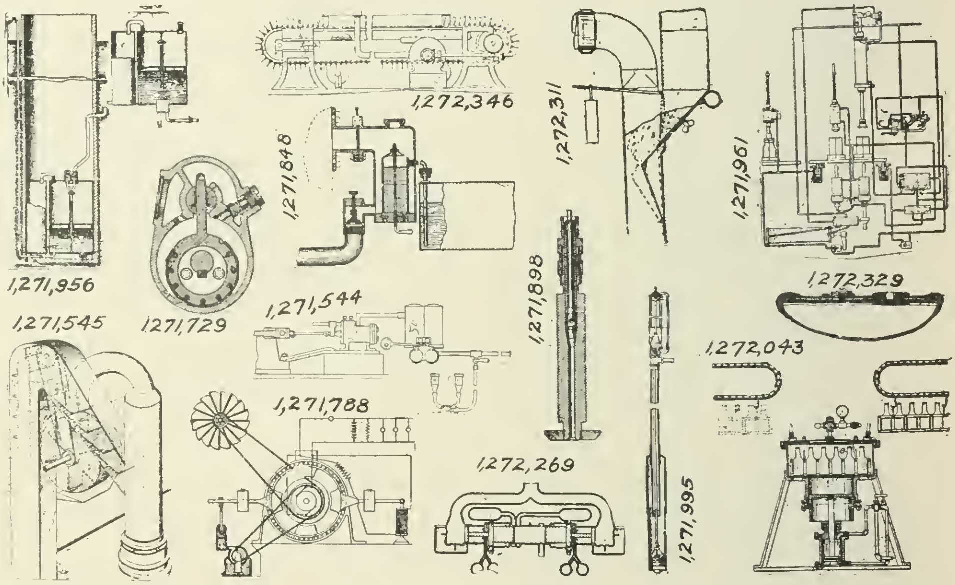
1,271,961. GLASS-FORMING MACHINE. William S. Teeple, Wellsburg, W. Va.

1,271,995. DEEP-WELL PUMP. Daniel Beedy, Colby, Kans.

1. In a lift pump, the combination with an air reservoir adapted to have direct communication with a pump cylinder, said air reservoir having a closed top, of a water supply pipe extending into and through the air reservoir through the closed top and of such smaller diameter than the air reservoir as to leave of material air receiving space thereby between and a plurality of lateral openings formed through the lower end of the water supply pipe.

1,272,043. METHOD OF TESTING AERATED-BEVERAGE CONTAINERS. John A. Hoff, St. Louis, Mo.

1. The method of testing containers of aerated liquids which consists in submerging the container in a body of liquid confined in a suitable tank or holder, and withdrawing a portion of the liquid body from its original confines to create a vacuum in the space originally occupied by the volume of the liquid thus withdrawn, whereby the container is subjected to a test under the absolute pressure of the contained gases.



Pneumatic Patents July 9

1,271,729. COMPRESSOR. Laidslav F. Kristufek, Chicago, Ill.

1,271,788. VARIABLE-POWER REGULATION. John A. Snee, Jr., West Elizabeth, Pa.

1. An elastic fluid pump operating without a fly wheel, which comprises a power chamber having inlet and discharge valves, a play pipe in operative relationship therewith containing space for a reciprocating piston, means forming a space in advance of the piston for an elastic fluid with inlet and discharge valves, a piston adapted to be actuated in one direction, by the energy of a primary actuating medium to compress and deliver elastic fluid, and in the opposite direction, the return stroke, by elastic fluid pressure, and means comprising piston, cylinder, and discharge port suitably located with respect to the compression space beyond, whereby the total energy stored in the elastic fluid utilized for causing the return stroke is maintained approximately constant.

1,271,848. VACUUM-FEED CARBURETER. Thomas William Burr, Stoneham, Mass.

1,271,898. PNEUMATIC VALVE. Edward E. Holtz, Chicago, Ill.

1,272,269. UTILIZING AN EXPANSIVE FORCE IN THE MOVEMENT OF LIQUID. Herbert Alfred Humphrey, London, England.

1,272,311. PNEUMATIC SEPARATING SYSTEM. Harold M. Plaisted, Granite City, Ill.

1,272,329. PNEUMATIC ABDOMINAL SUPPORT. Rose Schuessler Carling, Los Angeles, Cal.

1,272,346. APPARATUS FOR DRYING BOTTLES. Frederick L. Jefferies and William Spain, Riverside, Ill.

JULY 16

1,272,358. PORTABLE SOLDERING DEVICE. John Montgomery Bell, Chester, S. C.

1,272,374. METHOD OF PREPARING VACUUM-TUBES. Oliver Ellsworth Buckley, East Orange, N. J.

1,272,378. POWER-GENERATING APPARATUS. Elbridge C. Collins, Detroit, Mich.

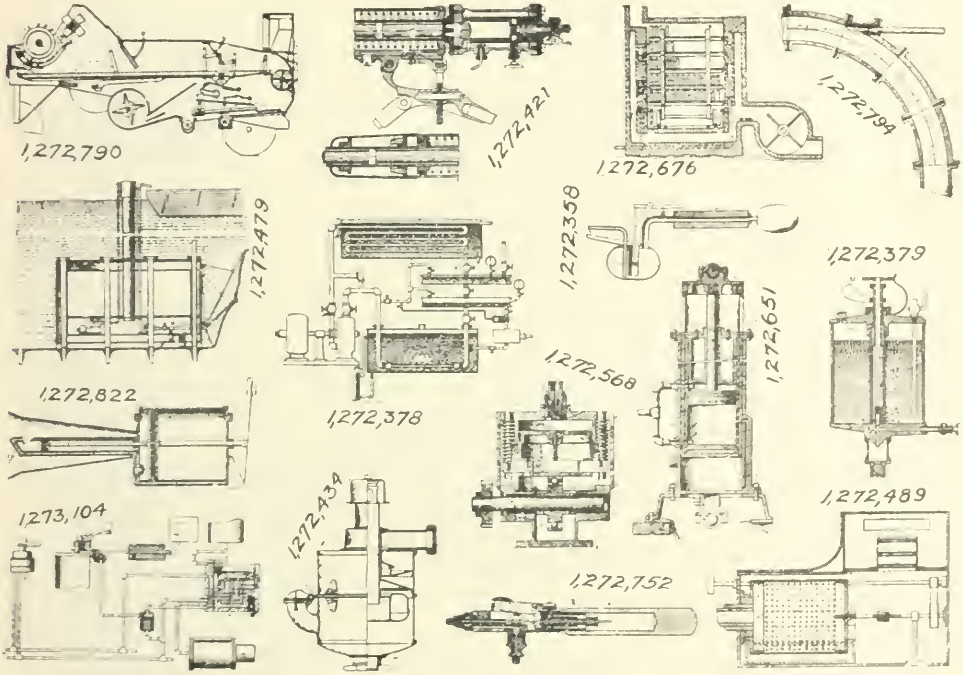
1,272,379. AIR AND LIQUID SUPPLYING DEVICE. Frank W. Collins, Mainstee, Mich.
1,272,421. APPARATUS FOR THROWING PROJECTILES. Angelo Glissenti, Brescia, Italy.
1,272,434. AIR-WASHER. Donald T. Hastings, Detroit, Mich.
1,272,438. AIR-BRUSH. Stephen J. Heinrich, Newton Highlands, Mass.
1,272,479. METHOD OF BUILDING FOUNDATIONS FOR SUBAQUEOUS TUNNELS. Duncan D. McBean, New York, N. Y.
1,272,489. DUST-COLLECTOR. Frank A. Marasclo, Phillipsburg, N. J.
1,272,568. AIR-PUMP. Willis A. Swan and William A. Higgs, Detroit, Mich.
1,272,611. AIR-COMPRESSOR. Charles L. Braley, Cincinnati, Ohio.
1,272,651. AIR-COMPRESSOR. Lewis L. Foster, Govans, Md.

1,273,171. GAS AND AIR MIXER FOR GLASS-FURNACES. Emile Majot, Maunmee, Ohio.
1,273,255. PNEUMATIC STRAW-STACKER. Wallace F. MacGregor, Racine, Wis.
1,273,303. AIR-TORPEDO. Frank B. Wuebben, Dayton, Ohio.
1,273,304. PRESSURE-REGULATING VALVE. Charles E. Yates, Detroit, Mich.
1,273,343. PUMP FOR VACUUM-CLEANERS. Charles Endorf, Jr., Chicago, Ill.

1,273,366. COMPRESSOR FOR REFRIGERATING APPARATUS. Fred J. Heideman, Detroit, Mich.

1,273,483. TIRE-PUMP FOR AUTOMOBILES. Thomas A. Halleran, Flushing, N. Y.

1,273,501. APPARATUS FOR CHARGING COMPRESSED AIR WITH ATOMIZED LIQUIDS. Walter Edward Kimber, Harlesden, London, England.



PNEUMATIC PATENTS JULY 16

1,272,676. DRIER. Charles H. Klein, Chaska, Minn.
1,272,752. AIR-BRUSH. Olaus C. Wold, Chicago, Ill.
1,272,790. GRAIN-SEPARATOR. Christian Frantz, Niagara Falls, N. Y.
1,272,794. ASH-CONVEYOR. Alexander Girtanner, New York, N. Y.
1,272,822. WHISTLE. Charles Walter Lund, Willow, California.

1. A whistle, a pump for supplying compressed fluid for operating the same, and means for simultaneously changing the size of the fluid chamber of said whistle with the movement of the piston of said pump.

1,273,097. ROCKING-CHAIR FAN. Joseph Schmalzi, South Bethlehem, Pa.
1,273,104. SAFETY CAR CONTROL. Walter V. Turner, Wilkinsburg, Pa.

JULY 23

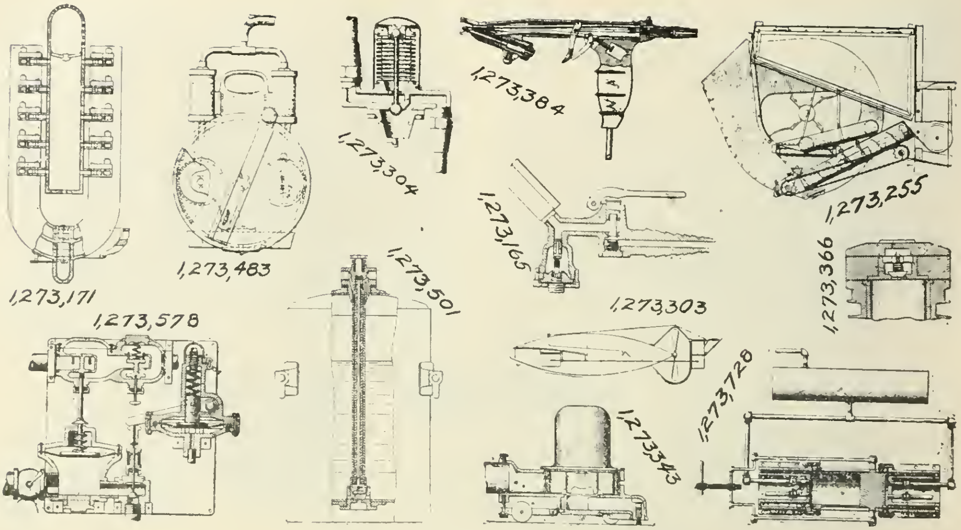
1,273,165. AIR-GAGE DEVICE. George H. Erich, Minneapolis, and David S. Milne, Fairmont, Minn.

1,273,578. SAFETY CONTROLLING MECHANISM FOR COMPRESSING-MACHINES. George P. Carroll, Hartford, Conn.
1,273,579. GOVERNOR FOR AIR-MOTORS. Melville Clark, Chicago, Ill.
1,273,728. AIR-COMPRESSOR PUMP. George Burd and Charles Burd, Hazelwood, Pa.
1,273,784. PNEUMATIC PAINT-BRUSH. Jens A. Paasche, Chicago, Ill.

JULY 30

1,273,813. PNEUMATIC SPRING SYSTEM. Raoul Bernat, Bordeaux, France.
1,273,900. VACUUM SYSTEM. Frank W. Miller, Chicago, Ill.

1. A vacuum system comprising a casing, a rotable spiral conveyor disposed vertically therein, a sediment collecting receptacle connected with the bottom of said casing, an air inlet pipe connected to one end of said casing, a discharge pipe connected to the opposite end of said casing, and means for delivering water or other liquid in regulated quantities to said air supply pipe.



Pneumatic Patents July 23

1,273,905. PRESSURE-REGULATOR FOR PNEUMATIC TIRES. William M. Myers, St. Joseph, Mo.

1,273,910. HAND-BRAKE. John F. O'Connor, Chicago, Ill., assignor to William H. Miner, Chazy, N. Y.

3. In a brake rigging having power controlled brakes, the combination therewith of auxiliary, manually controlled, adjustable means for applying variable predetermined braking forces.

1,273,929. METHOD OF TREATING GASES. Abraham Cressy Morrison, Essex Fells, N. J.

1,273,942. OIL-BURNER. John F. Smith, Seattle, Wash.

1,274,036. AIR-OPERATED CLAMPING DEVICE. Merbitt R. Hansen and Alfred C. Houser, Columbus, Ohio.

1. In molding apparatus, the combination of a turn over support for a core box or flask, a cylinder movable with said support and having a piston, a clamp actuated by the piston for clamping a plate or board to the box or flask, pipe connections with the cylinder at both sides of the piston and a valve for regulating the admission and exhaust of pressure medium to the cylinder.

1,274,055. PNEUMATIC ACTION. Alfred Johnson, Arthur C. Swanson and Alfred H. Utterberg, Chicago, Ill.

1,274,058. AIR-CLEANER AND PROCESS OF CLEANING AIR. Oswald Kutsche, Pittsburg, Pa.

7. The method of treating air, which consists in causing the air to flow at high velocity through a spiral tube located in a strong magnetic field, and separately removing gases from the outer and inner portions of the tube.

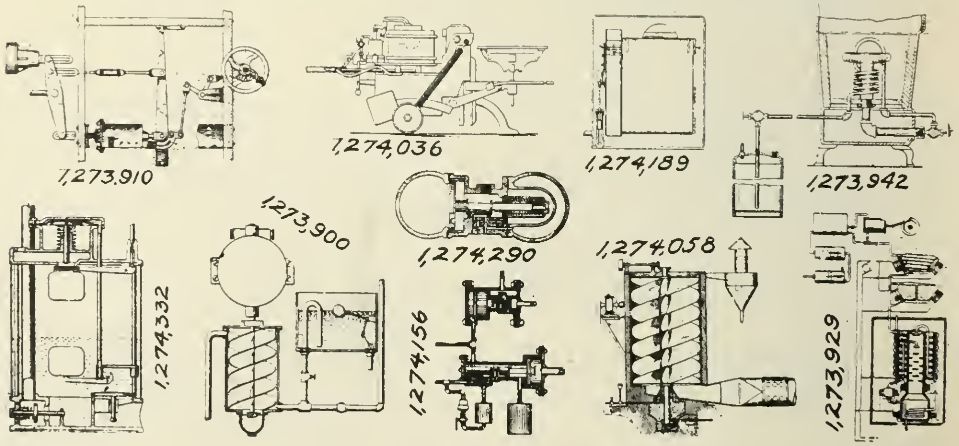
1,274,156. AIR-BRAKE MECHANISM. David J. Franklin, Columbia, S. C.

1,274,189. FLUID-PRESSURE RECORDER. Theodore W. Newburn, Edgewood, Pa.

1,274,193. AIR-BRAKE SYSTEM. George J. Pilger, Scranton, Pa.

1,274,290. REPEATING ACCELERATOR FOR COMPRESSED-AIR BRAKES. Joseph de Lipkowski, Paris, France.

1,274,332. PNEUMATIC PUMP. Homer S. Rogers, Milwaukee, Wis.



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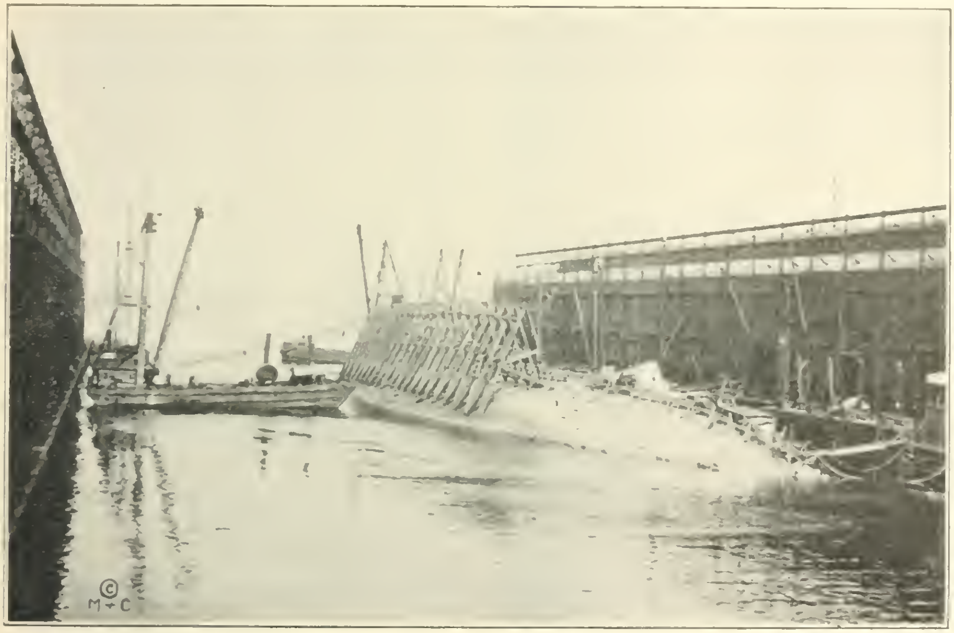

READY TO ROLL THE ST. PAUL

THE WONDERFUL SALVAGE FEAT OF RAISING THE ST. PAUL

The refloating of the wrecked steamer St. Paul—wrecked not on a rocky coast or on the open sea, but in the quiet of New York harbor— is to be reckoned as one of the greatest feats of salvage engineering. The entire story of it was graphically narrated by Robert G. Skerrett in *The Sun*, New York, on Oct. 13, and from that account we abstract freely.

The St. Paul was to have done her share in the transportation of troops and supplies across the Atlantic, and for this purpose she had been refitted in a local shipyard, was towed to her pier to take on her load and while being warped to her berth she heeled heavily to port, water poured in through various openings and she filled and settled to the bottom with her starboard side uppermost and only fifteen feet above the surface at low tide.

In rolling over the liner smashed her smokestacks, crumpled up her masts and dumped overboard into the narrow space between the pier and the ship, a confused mass of loose material of all descriptions, and at the same time she sank fourteen feet into the mud. The slip also was so narrow between the piers that this was an additional and most serious complication.

A DOUBLE PROBLEM.

The wreck presented a twofold problem to the engineers; first, to roll her upright, and second, to pump her out. But first it was necessary to clear away the damaged masts and smokestacks, remove top weights amounting to hundreds of tons, hoist off her guns and get rid of the litter that lay submerged beside the ship just where the divers would have to operate.

When the ship sank she carried down with her a number of rapid fire rifles intended to repel attacking U-boats. Weapons of that sort were too much in demand to let them remain idle until the St. Paul could be made ready again for sea. Therefore one of the first things called for in lightening her was the removal of the guns.

Those on the starboard or upper side of the wreck were above the surface of the water and could be removed easily, but the lower guns on the port side presented a very different task. They were buried deep in the mud, ten or more feet, and were quite beyond the reach of the underwater workers.

COMPRESSED AIR GETS TO WORK.

In order that the men might reach the guns the silt overlying the rifles had to be excavated For this purpose compressed air led through hose was employed to blow away the mud. When the pieces were thus uncovered slings were attached to them so that the weapons could be hoisted to the surface at the right moment, but with this done the most ticklish part of the salvage of the rapid firers yet remain unaccomplished.

Before the guns could be raised it was necessary to cast them loose from the deck, to which they were secured by massive bolts and nuts.. The divers achieved this despite the dim vision possible in the muddy water and the uncertain footing.

Again, the crumpled masts and smokestacks had to be got out of the way. Not only were these considerable weights, with tangled stays and rigging, but in the case of the funnels the masses of steel were of great bulk and awkward to deal with. By means of skilfully placed sticks of dynamite the masts were severed, and the smokestacks were similarly blasted free about six feet above the uppermost deck.

The following information detailing the successive stages of the work is furnished us by Mr. Ralph E. Chapman, Salvage Engineer of the Merritt & Chapman Wrecking Company.

When the St. Paul sank and settled into the silt at the bottom of the slip the mud entered the lower part of the liner through numerous openings and also accumulated in the alleyways along decks 1 and 2 on the port side. This accumulation went on from day to day, and it was important that the hampering process be halted or checked as far as possible, especially inside of the craft.

Accordingly, divers were sent into the St. Paul at the earliest moment for the purpose of closing all open portholes through which mud might continue to ooze inboard. Only the most expert of our men were chosen for that work, and it was necessary to be particular in that respect, for their tasks were both difficult and dangerous.

Lying as the ship was over on her side the silt had flowed into her through scores of open ports and the points to be reached were buried in blankets of mud ranging from six to eight feet thick. The divers had to search out these openings by using air and water jets, and to get to their objectives it was needful that they follow devious routes and go along passages filled with many pitfalls. The submerged interior of the liner was inky black, and the underwater workers depended entirely upon their acute sense of touch.

FITTING A COVER TO AN OPEN PORT.

While exploring for openings the divers found that a large hole existed which it was imperative should be closed. This inlet for the mud was in an awkward place and a good many feet under water. There was no way to seal it except from within the ship, because the place could not be reached from the outside.

The job involved making a pattern of the opening and its existing bolt holes, fashioning a patch plate and then carrying the plate down and fitting it in place. Again the divers who made the pattern and afterward closed the port worked without light, and notwithstanding there were nearly thirty bolts to be placed and as many nuts to be tightened the installing was effected in less than two days. The patch when subsequently inspected was found to be absolutely watertight.

Not only were the divers required to close all openings that were likely to interfere with the pumping out of the liner in refloating her, but it was equally necessary to create openings to facilitate the draining of the water to points where it could be reached by the pump intakes. In a number of cases bulkheads and other steel barriers were broken through by means of dynamite to facilitate this movement of the contained water, and the sticks of explosive were tied in place by our underwater workers, the charges being afterward set off by electricity.

UNDER WATER CUTTING TORCH.

The objection to this procedure lies in the rather extensive structural damage invited locally and the resulting cost of repairs. To offset this J. E. Kirk, machinist foreman and a capable diver, and Mr. Chapman experimented for weeks with a cutting torch of their own devising, and eventually they succeeded in perfecting it so that the oxy-acetylene flame would do its work under all conditions. They were able to cut holes with precision and despatch through any steel wall, and openings were thus made up to fourteen inches in diameter, the actual cutting time being a matter of a very few minutes. The deepest opening made in this way within the St. Paul was more than fifty feet below the surface of the water.

The work inside the liner involved the sealing of several hundred openings of one sort or another. It was decided at the start to isolate the forward and after ends of the craft from her middle body and to pump out the bow and stern regions. To this end it was necessary to close certain of the hatches and to provide temporary barriers.

MAKING WATER-TIGHT COMPARTMENTS.

For this work we used massive cement patches and walls, which we installed under water. These proved entirely satisfactory and enabled us to exert buoyant impulses just where we wanted them during our initial efforts to turn the vessel upright. The water was controlled by more than twenty pumps, three of them being twelve inch centrifugal wrecking pumps.

Because of the confined area in which the St. Paul lay it was not deemed practicable to approach her as we might otherwise have done had she been sunk in open waters. The ship sank in a way to block to a large extent the slip between Piers 60 and 61. The slip is 240 feet wide, while the St. Paul, lying on her side took up quite eighty feet of this, and at one point there was but fifty feet between her upper structure and the nearby dock.

The liner is 535 feet long and has a beam of 63 feet, and as a mass to be moved she represented more than 13,000 tons, fully double the weight of any other craft ever refloated from a similar posture. We realized that special facilities would have to be employed to roll the craft over on an even keel from her heel of 73 degrees.

TO ROLL HER OVER.

The problem was to turn her upright without shifting her laterally the while, and the rolling pull called for leverage exerted differently at different stages of the work. To facilitate the righting operation there were constructed and placed on the upturned starboard side of the St. Paul twenty-one tripods, technically termed A frames, fashioned of steel and timbers, and steel hawsers led from these to twenty-one cement anchoring blocks, each of ten tons, sunk in a trench dredged for them in the slip to the south and between Piers 60 and 59. The pull on these tackles was exerted by twenty-one hoisting engines firmly secured to the deck or floor of Pier 60.

LIFTING PONTOONS.

All during the month of May dredging operations continued on both sides of the wreck for the double purpose of clearing the way for the divers and on the south side of providing deeper water into which the liner might be shifted during the concluding work of righting and refloating her. The divers had to get close to the ship to attach the chains and steel hawsers which, with the aid of pontoons on the north side, were to help roll the craft upright. The other aid to the movement was the series of A frames just mentioned.

After weeks of preparation the rolling operations were started on July 22 and continued until July 28, the ship by that time being brought up to a point where her heel was reduced to 27 degrees, which was as far as the pontoons could be utilized effectively. This ended the first stage of the moving of the craft. The pontoons, which had co-operated with the A frames, were now taken off the job and the work was then started of completing the closing up of the entire ship so that she could be pumped out as a whole.

COFFERDAMS.

Closing up called for the building of a cofferdam more than 360 feet long on the port side and something over 290 feet on the starboard side. By means of these cofferdams the liner was finally made watertight to a level just above the river's surface at high tide and she was, in effect, converted into a gigantic flask which could be drained deliberately by the array of pumps assembled upon her decks.

The chains previously attached to the pontoons during the pulling on the A frames were next gripped forward and aft by two great wrecking craft, the derricks Monarch and Commander, which exercised a lifting and heeling force while the pumps were getting rid of the water within the St. Paul. In this way the salvors succeeded in bringing the vessel back within 16 degrees of vertical. This ended the second stage of the work.

The third stage of the undertaking consisted in pumping the entire ship while steadying her by four floating derricks, two on each side. This was done on September 11, and within five hours after starting the pumps the liner floated clear of the bottom fore and aft, assuming a position with a list of 4 degrees to port, which was due to the mass of wreckage that had gathered there when the vessel sank and turned over. This heel was overcome by the placing of compensating ballast on the starboard side.

Once fully afloat workmen were placed on the ship cleaning her up and installing certain apparatus for the liner's machinery. While as much mud as possible was removed during the various stages of rolling and raising the St. Paul, still when she was finally afloat it was found that there yet remained a thousand tons of the oily, smelly silt throughout the craft on her port side. This was got rid of and the St. Paul was turned over to representatives of the American Line on September 27.

Great credit is due Capt. I. M. Tooker, the wrecking master, whose shoulders bore the supervisory burden of the entire job. Undismayed by snapping hawsers and the occasional failure of other apparatus, he watched over the task like a general guiding a battle and mustered his corrective forces with winning skill.

OXY-ACETYLENE PROCESSES IN THE WAR*

The war with its constant call to meet emergencies and new and unexpected situations has demonstrated the value of the oxy-acetylene process.

Ammunition requirements have given a great impetus to its use in the welding of depth bombs, aero bombs, grenades, sea mines and torpedoes; in cutting off bars for slugs and shells; in reclamation of defective shells, cutting billets for gun forgings, etc. The process is used to large extent on Liberty trucks and motors, and in the construction of aeroplanes and motors. It has been invaluable in reclamation work. The constant damage caused by wear and tear, accident or shell fire at the front makes it imperative to reduce wastage to the minimum copatible with speed of replacement or repair. A broken or injured part means idleness until a new part is supplied or the damage is repaired. If the repair can be effected economically and speedily it follows thaat the damaged part will not be wasted, that the call for new parts will be reduced, and that much valuable hauling space will be saved by not having to constantly bring in repair parts. It may often happen, however, that the damage is not confined to one part and involves thorough overhauling or replacement on a large scale, making the object in question, whether it be a truck, locomotive, aeroplane, or what not, useless for a certain time and imposing an additional burden on transportation; in a number of cases the damage done is so great that replacement is impracticable. Oxy-acetylene welding meets the problem in that broken or otherwise injured parts may be speedily and efficiently reclaimed and that badly damaged objects needing general overhauling can be put back into activity within a short time.

The machinery of the interned German vessels was so badly damaged that it was looked upon as a difficult job to put them into commission, as many of the injured parts could not be made with the machine equipment we had in this country at the time. The only recourse was to restore the damaged parts and this was successfully accomplished by welding, using the electric arc and the oxy-

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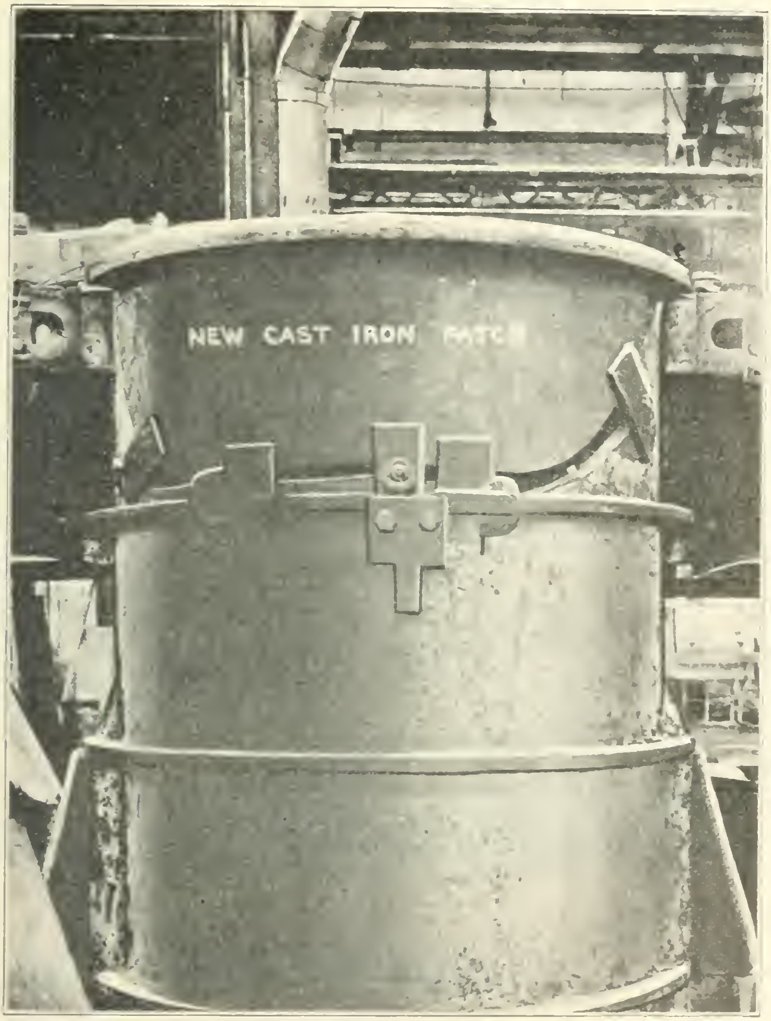
*From Bulletin No. 11, Federal Board for Vocational Education.



READY FOR THE WELD

acetylene flame. (See cut). In some cases the oxy-acetylene cutting blowpipe had been used to do the damage. The cuts were nicely filled in and camouflaged, but a clumsy error was committed in forgetting that what oxy-acetylene can destroy, oxy-acetylene can restore—and restore it did, for not one of the damages passed undiscovered. In towing one of these ships, the *Huron*, to the Brooklyn Navy Yard, it was found necessary to cut off 20 feet of mast in order to pass under the Brooklyn Bridge. The oxy-acetylene blowpipe came into play and the work was performed satisfactorily and in a short time.

Oxy-acetylene has, in some cases, been found more efficient by the armies for wrecking bridges and other structures than dynamite.

An acetylene blowpipe of special construction is used by submarines for cutting nets under water.

In action before Belgrade the turret of a gunboat was struck by a shell and partly demolished, imprisoning the men. After the action was over a hole was cut in the turret and the men liberated.

It is known that when possible the Germans have damaged by the oxy-acetylene flame guns about to be captured by the enemy.

OXY-ACETYLENE WELDING IN THE FRENCH ARMY

Oxy-acetylene welding is used extensively by the French Army for both manufacturing and repair work. Its use in manufacturing is practically the same as in the United States. In repair work it is used at posts situated out of range of shell fire, as it has been found that the men can not do efficient work when exposed to fire. It is also used at all base repair shops at Paris and other cities. Whenever possible, damaged parts are replaced by new ones, otherwise the work is moved to a repair camp in the rear. At the repair camp the work is usually carried on in a small hut about 12 feet square, although in some cases it is done in the main repair sheds. Acetylene is usually generated at the repair huts, and is used in cylinders only when necessity demands it. Portable generators are employed for large work which can not be handled niside the hut. Oxygen is obtained in cylinders holding from 6 to 7 cubic meters.

The use of the process by the French Army has two limitations: First, lack of capable welders; and, second, limited supply of oxygen cylinders.

With the first call to the colors the men experienced in welding were sent to the trenches, but later were recalled to industrial work, especially in the manufacture of bombs used in trench warfare, aeroplanes, etc. As a consequence very few men can be spared for repair work at the front, and there is a consequent loss, wastage, and burden on transportation which could otherwise be avoided.

Organization.—Each army has its own corps of engineers, autos, artillery, railroads, aeroplanes, and each one of these divisions looks after its own repair work. So far as oxy-acetylene is concerned they work independently of each other.

Apparatus.—The apparatus used in the Army is practically the same as that used in industrial work. The amount of apparatus needed depends on number of heavy guns, light guns, motor cars, miles of track, airplanes, bridges, amount of piping, activity of the Army, etc.

Field of Utility.—The oxy-acetylene process is used in the following branches: Aeroplanes (including lorries), artillery, automobiles (autos, trucks). engineers, railroad work.

Aeroplanes.—One welding set and two expert men are used for each 150 aeros. This is independent of welding apparatus used for motor lorries. The French do not repair cracked motor cylinders at the front, as they feel that so much depends upon the motor that they can not afford to run any chances.

Artillery.—One set of apparatus and two expert welders for each 100 guns of 105 mm. to 280 mm. cali. Somewhat less for smaller calibers. This will also take care of trench guns and mortars. The welding is mostly done on gun .carriages, accessories, gun feet, etc., rather than on gun or barrels themselves. When badly damaged, the artillery is sent to the repair camp. New guns are daily sent forward, and the old or damaged parts are returned to the park, as the artillery camp is called. The park is equipped with lathes, forges, etc., so that extensive repairs can be made. When guns are too badly damaged, the undamaged parts are used in forming new ones. Two experienced men are used in this assembling work. Two experienced men are used for each welding set, as well as two or three helpers—inexperienced soldiers or even German prisoners being employed as helpers.

Automobile Service.—Autos are subject to damage by ordinary wear and tear, accidents, and shell fire. Autos breaking down en route are repaired, where possible, by replacement of old parts by new ones, broken parts being returned to parks or else thrown away. There are about 50 such parks in France taking care of 1.000 to 2,000 cars each. Outside repairs to cylinders are executed at parks, but inside repairs at Paris, where suitable boring tools are to be found. At one reserve park situated about 30 miles from the front they employed three sets of apparatus and four men and used 1½ bottles or 10 cubic meters of oxygen per diem. This park served 3,000 automobiles. One set of apparatus and two men are needed for each 400 to 500 autos, including trucks and passenger autos.

Engineers.—The departments of the engineers are: Department of bridges, electricity, searchlights, engineers' park for waterworks, etc. The last two departments mentioned do not employ oxy-acetylene welding.

Department of Bridges.—One set of apparatus and two welders are furnished to each army corps. Dissolved acetylene is used on account of its transportability. The process is used for cutting broken bridges and repairing pontoon boats, and, as the men have to

(*Concluded on page 8958*).

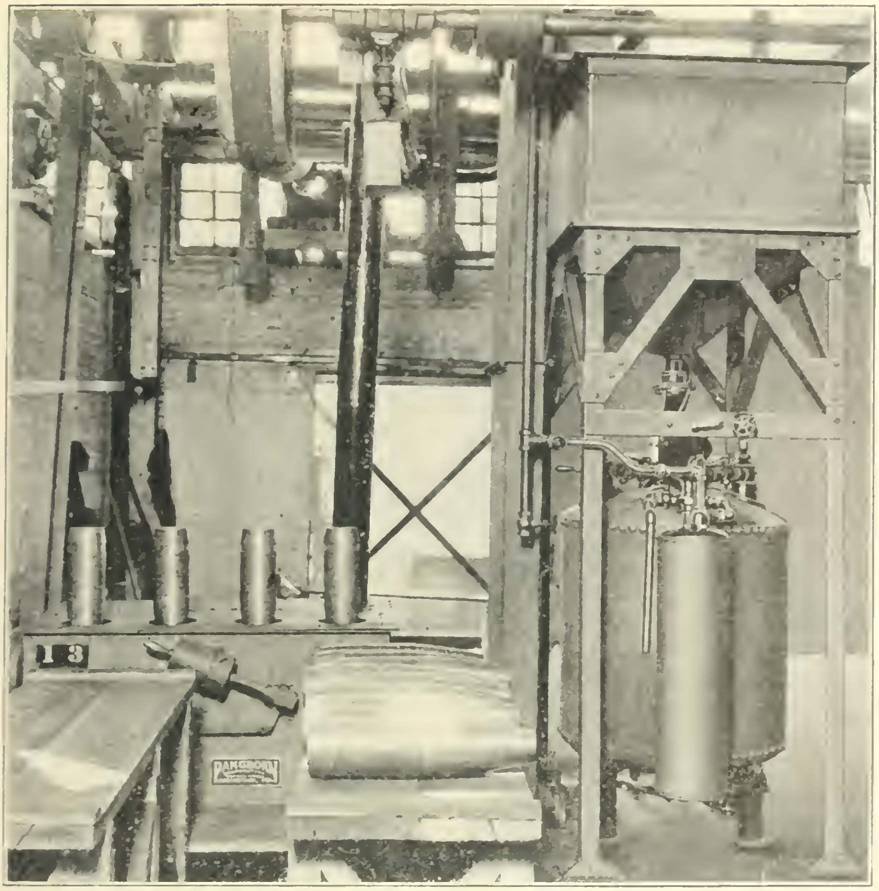


FIG. 1

AN AUTOMATIC SHELL CLEANSING SAND BLAST APPARATUS

In the processes of shell manufacture the perfect cleaning of the interiors is an operation of importance and the sand blast is most efficient for the purpose, while the numbers manufactured have made an imperative demand for apparatus specially adapted to the work. The arrangement here shown, built by the Pangborn Corporation, Hagerstown, Maryland, provides continuous operation for cleaning 155 mm. (6.1 in.) shells with direct high pressure air. Fig. 1 is a front and Fig. 2 a rear view of the entire arrangement. Primarily it consists of a cabinet in which are mounted four rotating chucks or carriers driven at slow speed on dust protected ball bearings. The chucks are driven by belt from a main drive at the rear of the cabinet, see Fig. 3, the alternate chucks turning in opposite directions. All the rotating mechanism is contained in a separate dust tight compartment as shown.

A direct high pressure sand blast machine

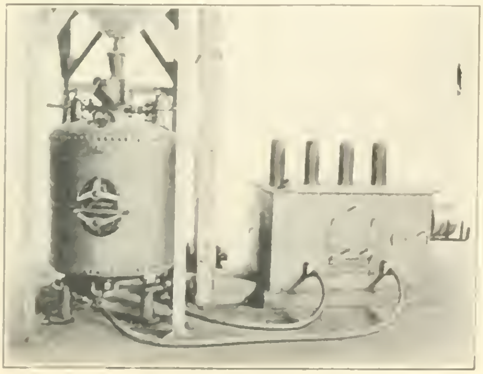


FIG. 2

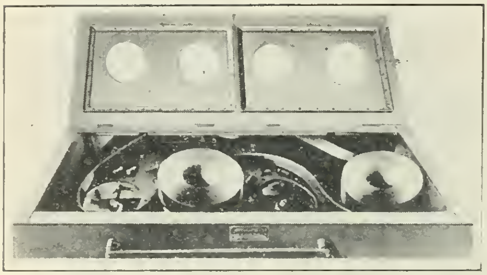


FIG. 3

with two lines of hose feeds two nozzles which are positioned to deliver the sand blast within the nose openings of alternate shells. The shells are placed in the rotating chucks with the openings downward, and as either two alternate shells are cleaned the nozzles are thrown over by a weighted hand lever on the front of the cabinet to the other two shells without stopping the blasting action, and then the cleaned shells are removed and other shells placed in the chucks for cleaning. Fig. 4 shows the suspending levers and the nozzles within the cabinet.

A hopper formed in the bottom of the cabinet receives the spent abrasive which is conveyed to an elevator and raised to a separator over the sand blast machine which by mechanically operated screens and strong exhaust at one operation removes both fine and coarse material which passes to a refuse bin, the clean, sharp abrasive for re-use being delivered to a storage bin for refilling the machine.

The machine may be used with either sand or the metal abrasives, and the equipment as here shown in actual practice is cleaning 90 shells 155 mm. per hour. The cabinet is also made for shells of other sizes as required.

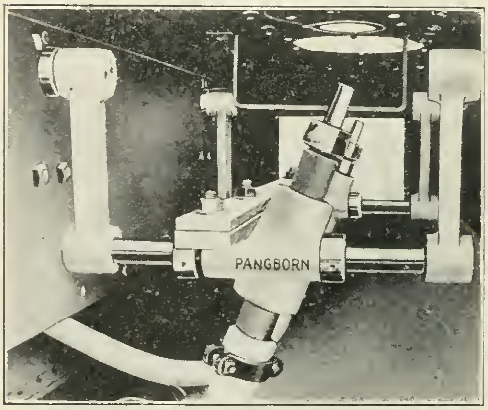


FIG. 4

THE MARBLE CAVES OF OREGON

By F. A. Tuck

Amid the wilds of Southwestern Oregon, almost unknown to the world at large, is situated a series of underground chambers and passages remarkable for their size and for the beauty and unusual character of their decorations. Within the last few years they have been made a national monument and are now known as the Marble Caves of Oregon.

At the present time a visit to the caves is no small undertaking. From Grants Pass or Medford, a thirty-mile drive, takes one to the camp at the end of the wagon road. The rest of the trip must be made on foot or mule back up a steep trail ten miles in length. During the summer months the Forestry Service stations a forester at the caves as guide and caretaker. He takes a special interest in conducting all visitors through the caves and in pointing out to them the many interesting features of the trip.

The caves consist of three and a half miles of marble passages and grottoes, ranging from one to four or five stories in height. In places the connecting corridors are so low that one must crawl on all fours for a considerable distance. Elsewhere the chambers are so large that the opposite walls and ceiling are scarcely visible in the dim candle light. The largest cavern measures over 500 feet in length and its arched ceiling is 100 feet above the floor.

Throughout the entire cave the stalactitic formations are rich and wonderfully varied. In some chambers the ceiling is a mass of small stalactites, from the points of whcih hang starlike glittering pendants—drops of water. In one superb room the roof is covered with gigantic inverted white tulips; in another folds of massive draperies cover the walls supported by immense fluted columns. Here stalactites reach down from above and embrace their stalagmitic sisters, thus forming pillars of surpassing symmetry and beauty. There a miniature Niagara stands outlined in white marble, beyond which a magnificent Solomon's Temple is carved deep into the heart of the mountain.

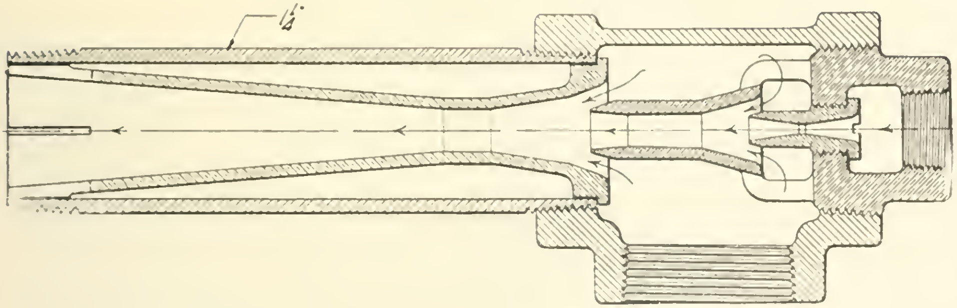


FIG. 1

AIR SYPHON BLOWERS FOR RIVET FURNACES

The use of high pressure air for rivet furnaces in a great majority of shipyards is not only overtaxing the capacity of the air compressor plants in many cases, but is resulting in a waste of power that does not seem to have been generally appreciated.

In a yard where 25% or 30% of the total air supply compressed to 100 lbs. is used to support combustion in rivet heaters at a pressure of less than ½ oz., the loss of power is readily apparent.

A large percentage of the high pressure air now used for this purpose can be saved by the application of a jet syphon to the air connection near the rivet furnace. The high pressure air passage through the nozzle of the syphon draws in a liberal quantity of free air which is mixed with the initial air, and delivered to the furnace with it.

The percentage of induced free air taken in under fixed conditions depends entirely on the more or less correct design of the syphon blower, and runs from 30% in some of the crude arrangements which have been improvised by some of the ship yards to 75% or 80% for the best standard makes of syphons, which have been carefully tested out by the Standard Practice Branch of the Emergency Fleet Corporation.

The higher efficiencies are obtained by multiple nozzle arrangements, in which a very small high pressure air jet (less than ⅛" in diameter for an ordinary rivet heater syphon) discharges through an injector tube drawing in a small quantity of free air. The first injector tube discharges into a second one forming a second syphonic action, etc., which is carried on through successive stages where high pressures are to be reduced to relatively low ones.

The accompanying cross sectional sketch, Fig. 1, shows a simplified design of a two-stage rivet furnace blower which is suggested in the interest of economy in construction, and Fig. 2 shows its application to a rivet furnace.

In this design a standard 1¼ in. screwed pattern cast iron tee is used for the body of the instrument. The self-contained cast brass nozzle arrangement is screwed into one end of the tee and provided with threaded connection for high pressure pipe, while the delivery tube connecting the body to the furnace is screwed into the other end. In order to give rugged construction and further economize in production, a short piece of standard pipe is used for the delivery tube and the correct syphonic proportions are obtained by the insertion of a non-corrosive lining. If the nozzles are properly proportioned, blowers of this design will give thoroughly good results.

Syphon blowers of the very highest efficiency can be obtained from regular manufacturers, and further information with reference

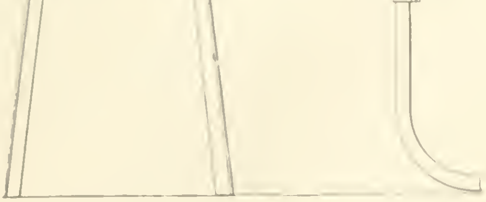


FIG. 2

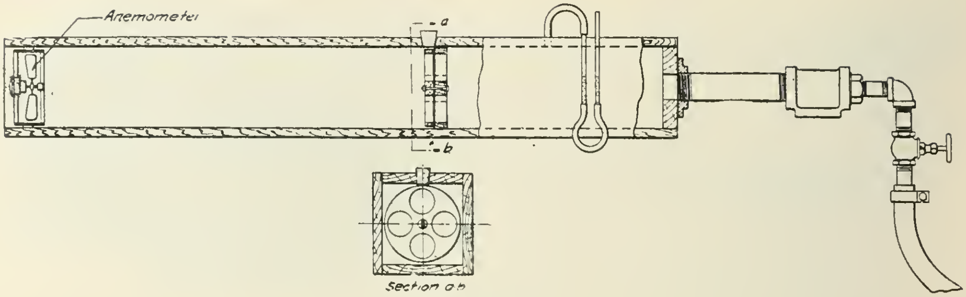


FIG. 3

to them will be furnished on request. It is quite likely that patterns and tools will be developed by some of these manufacturers for the production of the simplified instrumen illustrated herein, provided there should be sufficient demand for them, and in this case the tubes would no doubt be carefully developed for highest efficiency.

The average air used by a rivet furnace runs from 20 to 40 cu. ft. per minute. A properly designed syphon blower will easily reduce the high presure supply to 25% of the total, utilizing 75% of free air in the furnace.

Figuring the average furnace air supply at 20 cu. ft. per minute, the saving effected would be 1500 cu. ft. of high pressure air per minute or approximately 250 horse power for each 100 rivet furnaces in operation.

A few ship yards have made some progress in the application of the syphon blower principle to rivet heaters and some manufacturers are furnishing heaters with syphon attachments, but so far as these have been observed and tested out, they have not been designed for high efficiency, and as the matter stands it seems that even the few yards that have taken steps in this direction have not taken full advantage of the opportunity.

The cost of these blowers in any case is so insignificant in comparison with the saving effected that it is a great waste to use anything short of a thoroughly efficient instrument.

It is suggeted therefore that blowers be tested and that nothing be accepted or used which will not utilize 75% of induced air.

A very simple testing method is illustrated by the accompanying sketch Fig 3. In this arrangement the blower is attached to an opening in the end of a rectangular wood box approximately 3 feet long by 4½" x 4½" inside cross sectional measurements. A partition is located near the inlet and is fitted with a wooden disc loosely attached with wood screw at center. Four 1½" equidistant holes are bored through disc and partition, as shown in the sketch, for the diffusion and passage of the air, and a hole with stopper is provided through the top of the box immediately over the disc so that it can be rotated to gauge the size of the openings through the partition for the purpose of imposing a resistance or back pressure on the blower, equivalent to the resistance of the fuel bed in a rivet heater.

A bent glass tube partially filled with water is attached to the side of the box and connected with the first compartment to show the extent of this resistance, which should be adjusted to a ½" water head.

An anemometer is placed in the outer end of the box to register the flow of air which will be calculated in cu.ft. by dividing the anemometer reading by 8.

In testing open the air valves on the blower until the anemometer reading reaches 280 with the resistance adjusted at ½" of water. This would represent 35 cu. ft. of air per minute. Next close the free or induced air inlet of the blower without changing the adjustment of the air supply valve and this will give the net direct or high pressure air reading, which compared with the previous total will give the efficiency of the device.—*Emergency Fleet News.*

THE SCHOOP METAL-SPRAY PROCESS IMPROVED

By increasing the "atomizing pressure" in the "pistol" of the Schoop apparatus, metal deposits of very fine grain and high density and strength have recently been obtained. The pistol is a blow pipe in which the metallic bead, fused by the flame, is torn away and atomized by the current of compressed air. The ordinary working pressure of the air is 3.5 atmospheres, but the pistol operates on the injector principle, and the actual atomizing pressure was so far only 1.5 atmospheres. This atomizing pressure has recently been raised to 2.5 and 3 atmospheres without increasing the working pressure, with very promising results. A lead pipe 1 mm. wall thickness made by the improved process was filled with hydrogen at 5 atmospheric pressure while lying in water; no hydrogen escaped, while hydrogen bubbles forced their way through a lead pipe made by the old process. In another experiment plates of sheet-iron were covered with lead, one or two coatings at pressures of 1.5 or of 2.5 atmospheres. The one or two coatings of the old process did not prevent subsequent rusting of iron, but both the one coating and the two coatings of lead, deposited at the higher pressure kept the plates free of rust when they were placed in water.—*Engineering.*

LUBRICATION OF AIR COMPRESSORS

By W. H. Callan

The lubrication of the air compressor, steam cylinder, main bearings, crankpin, crosshead pin, crosshead guide, etc., does not differ from that of the ordinary steam engine, which is very well known and understood; hence the discussion in this article will be confined to air-cylinder lubrication only.

Years ago when we were young in the compressor business considerable trouble was experienced in procuring a suitable oil for lubricating the air cylinders of our compressors. After considering the matter for some time it was decided that an expert on the subject should be consulted. The matter was taken up with a well-known oil company whose representative called upon us, and after making careful examination of the conditions he reported that our trouble was entirely due to using an oil too light in body and too low in viscosity to withstand the high heat of the compression. He stated that the oil we were using was gasified, due to the high temperature of the air, and that it passed off in vapor, leaving the cylinder wall without lubrication, and recommended a suitable oil. The grade was 26 Baumé gravity with a flash point of 515 deg. F., fire test of 555 deg. F., and viscosity of 130 S. at 212 deg. F. After having used this oil for some time we found no improvement in the operation of the machine; in fact it appeared to be laboring and the temperature of the discharge air was very high. The cylinder heads were then removed, the valves taken out and a careful examination made. The cylinder wall seemed to have a sticky, plastic coating; the air passages and discharge cavity of the cylinder showed signs of dark deposits, while the faces of the valve seats were covered with a black, hard coating. This hard formation caused the valves, to leak, hence the increased temperature of the discharge air, and the sticky coating was responsible for the increased friction. The representative's attention was called to this condition, and he suggested that a little lighter oil be used, this time of 27½ Baumé gravity, flash point 450 deg. F., burning point 500 deg. F., and vicosity about 125 S. at 212 deg. F. On being asked if he did not think this was too heavy for air-cylinder lubrication he assured us it was not and stated that in order to withstand the high temperature of the compressed air it was necessary to have a rather low-gravity and high-vicosity oil with a flash point above the temperature of the air.

After using this oil for some weeks another examination was made, and while the cylinder wall appeared considerably better the valve passages and discharge cavities of the cylinder were badly coated with a hard deposit. The trouble was again brought to the attention of the expert and he suggested that we reduce the amount fed into the cylinder. This was done with great care until we were only using three drops a minute in a 14 x14-in. cylinder running at 150 r.p.m., but even under this condition deposits in the valve passages and the discharge cavities of the cylinder continued to form as long as we used this oil.

Several months after the expert's attention was again called to the condition experienced with his oil. In regard to the amount we were feeding into this cylinder he said this was reduced to a point that he thought was the minimum. His reason for the formation in the passages was that the residuum of all oils is carbon, and that is was no doubt due to carbon deposits. He assured us that the oil he had recommended was the best procurable for the purpose, and that we should continue to use it without fear of trouble, which we did. However, the formation in the discharge passages seemed to be building up rapidly despite the fact that we were feeding but a small quantity of oil into the cylinder. The formation had collected to such an extent that it was necessary to clean the passages in order to avoid an explosion. Some of the removed material was analyzed and found to contain about 1.5 per cent. free oil, 11 per cent. rust, 5 per cent. decomposed oil, 30 per cent. mineral ash, 10 per cent. coal dust and the remainder foreign matter, or residuum. A further investigation showed that our intake was exposed to coal dust, mineral ash, shavings, water, etc., as well as some air.

After cleaning the compressor and safeguarding the intake against dirt and dust, we procured another grade of oil which we believed was more suitable for the work, as we had investigated and studied the question in the meantime. This oil was of 31 Baumé gravity, flash point 375 deg. F., burning point 420 deg. F. and vicosity 200 S. at 100 deg. F. We started by feeding three drops a minute. Finding the cylinder copiously oiled the feed was reduced to two drops. The compressor was operated in this condition for a long time with practically no trouble from carbon deposits.

Experiencing such good results from this light oil and by this time disbelieving the virtues claimed for the low gravity, high flash point and heavy vicosity, we were prompted to try another grade of oil and selected one having a gravity of 33 Baumé, flash point of 380 deg. F., fire test of 420 deg. F., and viscosity of 140 S. at 100 deg. F. The same quantity was used as before, namely, two drops a minute in a 14 x 14 cylinder running at 150 r.p.m. This oil was used for years without any trouble in respect to lubrication, valve leekage and carbon deposits—in fact it proved to be very satisfactory in every way.

The oil representative made his regular calls on us and each time we told him what we were doing. He assured us we were on the wrong track and that sooner or later would get into trouble, but after continued tests and very careful observation of all conditions, we are satisfied that the latter oil is the most suitable for air-cylinder lubrication when working against 100 lb. pressure, either single or two stage.

One day an old friend called, who was also an expert for an oil company. On being told our experience with air-cylinder lubrication he too assured us that we were using the wrong oil and said, "You know you get not less than 400 deg. F.in your air cylinder when working against 100-lb single stage." With this I agreed. I then asked him how he knew we were wrong, and what means he employed for ascertaining the proper grade of oil for air-cylinder lubrication. He then explained to us the method his company's engineers use in determining the proper oil for different kinds of service. He said:

"Since you have agreed that the temperature of the air is 400 deg., our tests would be conducted as follows: Take a block of cast iron 6 in. or 8 in. square and 2 in. thick; place this block in a layer of sand in a shallow iron pan, pack the sand closely around the cast-iron block, then put a gas burner under the pan and turn on the heat slowly. The top surface of this block is polished and has a drilled hole, and into the hole a thermometer is inserted. Heavy steam-cylinder oil is poured into the hole around the thermometer bulb so as to make a close heat contact. When the thermometer rises to 400 deg. lower your gas burner until the thermometer remains at 400 deg. Then take your different samples, dip the point of a lead pencil into the oil, hold the pencil 2 in. from the surface of this iron block and allow a drop to fall on the hot polished surface.

A HIGHER GRADE OF OIL

"When such a test is made with the grade of oil from which you say you are getting successful results it is found the drop spreads out to about 1⅛ in. in diameter, smokes a little, dries up, and is evaporated in 10 sec. time, leaving the surface perfectly dry. With a higher grade of oil having a flash point of 450 deg. F. and heavy viscosity, when the drop falls on the surface of this polished block it spreads out to about 1¼ in. in diameter, smokes a little, but, after 5 min. the surface is still oily. Thus we have proof that this is the proper oil to withstand such service as you get in your air-compressor cylinder."

I asked him what he thought the temperature of the surface of the cylinder wall was when the air in the cylinder is 400 deg. F. He hesitated, then said he believed it would be about 25 deg. F. less than the temperature of the air. I disagreed, saying this did not seem right, as the water-jacketed wall should be much cooler than the air. We went into the office and consulted some authorities. We found some tests had been made abroad on the temperature of the cylinder walls in an internal-combustion engine where, with an explosion temperature of 2700 deg. F. and an average temperature through the cycle of 950 deg. F. and the water in the jacket at 200 deg. F., the inside surface of the cylinder wall did not go above 267 deg. F. When shown these figures my friend was nearly speechless and admitted that he had never thought that the temperature of the wall of an internal-combustion engine cylinder with an explosion temperature so high could remain so cool. However, as the character of the authority was such that is could not be questioned it was accepted by the oil expert. I then asked what he thought the temperature of the air-cylinder wall should be when the air does not exceed 400 deg. F. He said he did not know, but did not believe it would be very much above the temperature of the water in the jacket.

As a matter of fact, the temperature of the inside of the cylinder wall of a water-jacketed cylinder is not more than 30 deg. F. higher than the temperature of the jacket water, as long as the water does not boil; and since this is so, what is the use of using oils of low gravity, high fire test and high viscosity to meet a condition such as this one now appears to be? The temperature of the inside surface of the cylinder wall on an air compressor is very little, if any, above the temperature of the surface in the main bearing of the ordinary Corliss engine.

From this it appears that the expert who lays stress on high viscosity and flash point has not considered the true conditions. We have shown that the cause of carbon deposits in the passages of an air-cylinder is not always entirely chargeable to the residuum of oil, but in many instances is due to using an oil of too heavy body, which adheres to the passages of the cylinder, and furthermore, when the inlet is not properly protected from foreign matter, material such as coal dust, mineral ash, shavings, waste, etc., is drawn into the cylinder and deposited on the sticky surfaces coated with this heavy oil. This foreign matter, with the additional oil, gradually builds up until the passages become choked, and the air valves begin to leak for some reason, thus increasing the temperature, until finally it sometimes reaches a point as high as 500 deg. F. when compressing to 100 lb. single stage. It there are many shavings or very much coal dust deposited in the passages, it is apt to char and become incandescent. When it does, the temperature of the air rises very rapidly and, as a consequence, the pressure increases quickly to a point beyond the strength of the receiver and results in what is generally called an explosion

In my opinion no violent explosion ever takes place in an ordinary air compressor unless kerosene, gasoline or some such material is introduced.

I had an experience some years ago with a two-stage compressor where the intake had been neglected and also the wrong grade and quantity of oil had been used; the high-pressure discharge valve became leaky, allowing the air to churn in and out of the cylinder at each stroke and heating it until it became so hot that the heavy deposits in the passages actually took fire. The whole system burned out like a chimney of an old-time wood stove. Fortunately there was no explosion because the safety valve on the receiver relieved the sudden pressure caused by the burning material in the discharge passages and the compressor was promptly shut down.

From the foregoing it will be understood that in the selection of an oil for air-cylinder lubrication nothing should be used but a pure mineral product having a gravity of from 31 to 33 Baumé, a flash point of 375 to 390 deg. F. and a viscosity of 140 to 150 S. at 100 deg. F. Under no circumstances should a heavy grade be used despite any claim made by the oil salesmen of the virtues of heavy viscosities or high flash points. It should also be borne in mind that when the surface of the cylinder wall is once glazed over, very little oil is required to properly and adequately lubricate the working surfaces.

The film of oil on the cylinder wall is understood to be less than 0.00025 in. in thickness, and since in the operation of compressing air there is practically no moisture the piston rides back and forth on this film and requires very little oil to be added in order to maintain the quantity required. Should a greater amount of oil be used than just enough to keep up the required film it will be plowed up ahead of the piston and be forced through the valves and into the cylinder cavities, where it will collect in the low places and solidify by reason of being mixed with foreign matter taken in through the inlet.

As has been shown, a 14x14-in. cylinder can be adequately lubricated with two drops of oil a minute when the compressor is operated at 150 r.p.m, being the equivalent of one drop of oil for each 600 sq. ft. of cylinder surface swept by the piston. The oil here referred to was of paraffine base. However, I believe that an oil of about the same consistency, refined from an asphalt base, would serve as well if not better.—*American Machinist.*

PNEUMATIC CONVEYANCE OF DRY SAND

The illustrations here reproduced from a recent issue of *Electric Railway Journal* show the essential features of a sand car built by the United Railways of St. Louis. From this car the sand is unloaded by air pressure, and the results have been very gratifying both in the amount of labor saved and also in the time reduction. With a crew of two men the car will deliver about 1,000 cu. ft. of sand per day, as compared with 400 cu. ft. per day with four men when unloaded manually. The method employed is of course not original but its application of this case exemplifies good practice. The body of the car consists of a 15-in. 60-lb. I-beam frame mounted on the company's standard diamond-frame truck and driven by four 50- hp. Westinghouse motors. The car is 30 ft. long over the bumpers, and approximately 8 ft. 6 in. wide.

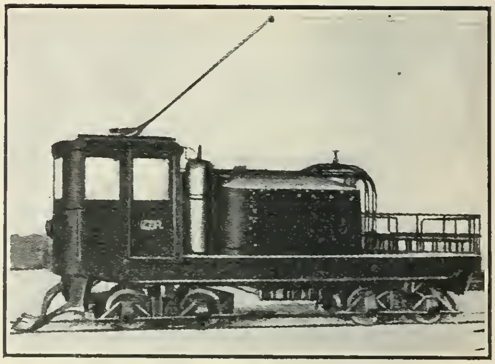


FIG. 1

The large sand tank, which is 12 ft. in diameter and has a capacity of 360 cu. ft., is placed in the middle of the car. In the concave bottom of this tank there is an opening to which is riveted a T-shaped casting. A 4-in. discharge pipe leads from one side of this casting and extends vertically up the back of the tank and over the top by means of two large radius bends. A wire-bound rubber hose is attached to the free end of this pipe. There is a 4-in. gate valve at the end and a swivel joint between the bends so that the pipe may be turned at any angle. Directly opposite this opening in the casting is a 1¼-in. pipe leading to the compressed-air equipment.

The compressed-air equipment consists of two type DH-25 Westinghouse motor-driven compressors capable of delivering 25 cu. ft. of air per minute at 90 lb. pressure, and two 18-in. by 72-in. air reservoirs which are connected to the sand tank through a quick-opening valve. The compressors are located in the

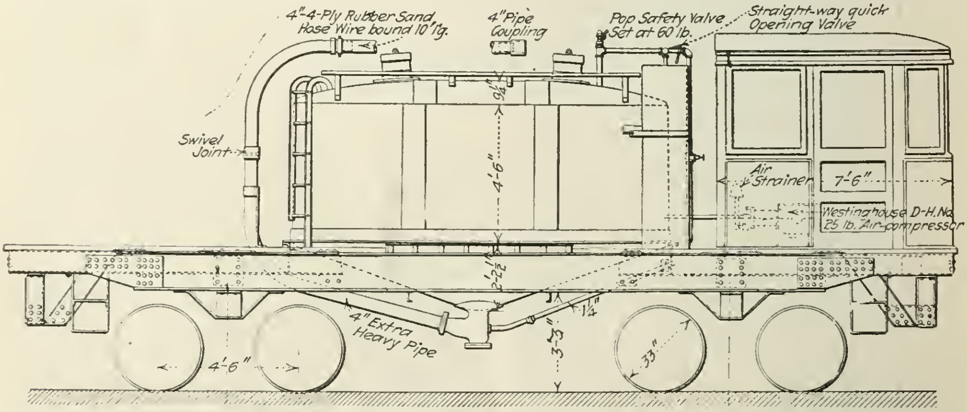
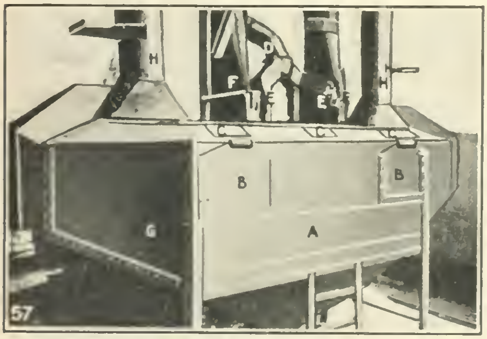

4"-4-Ply Rubber Sand Hose Wire bound 10' lg.
4" Pipe Coupling
Pop Safety Valve Set at 60 lb.
Straight-way quick Opening Valve
Swivel Joint
9¼"
4'-6"
Air Strainer
7'-6"
Westinghouse D-H. No. 25 lb. Air-compressor
2'-2½"
1¼"
4" Extra Heavy Pipe
3'-3"
33"
4'-6"

FIG. 2

driving cab which takes up 7 ft. 6 in. of space at one end of the car. This cab has a 30-in. sliding door in the rear end and is 7 ft. 3 in. high, giving a total height from top of rail of 11 ft. 10¾ in. The air reservoirs are located between the cab and the tank. After having been in operation some time, it was found to be advantageous to install two additional air reservoirs of the same size and so arranged with check valves that a back pressure of 20 lb. is always upon the compressors. This is to prevent the compressors from racing when the pressure in the reservoirs is suddenly thrown into the sand tank.

The operation of the car is very simple. The car is loaded at the dry sand plant through the two openings in the top of the sand tank. The caps are screwed on and the car proceeds to the bins. Pressure is pumped up in the reservoirs while the car is traveling, and upon arrival is turned on to the sand through the quick opening valve at a pressure of from 25 to 60 lb. per square inch. The sand is forced down into the T shaped casting at the bottom of the tank and, assisted by air pressure entering the T through the 1¼ in. pipe, is forced up and out through the stand pipe and hose. Sand begins to flow at 25 lb. pressure, but operates best at about 40 lb. The tank is designed for 60 lb. working pressure, and is protected by a safety valve at the top.



A SPECIAL SAND BLAST MACHINE

An elaborate serial article describing the manufacture of the Comptometer current in the *American Machinist* contains the following account of the sand blast apparatus employed:

A number of parts must be sandblasted, and as no satisfactory machines for this work could be purchased, the one here shown was designed and built.

The body of the machine *A* carries a shaft with a set of pulleys at each end, over which pass endless rubber belts for carrying the work under the blast nozzles. Under the machine is a hopper, through which the spent sand runs by gravity to a storage bin from which it is carried by elevators to a supply bin overhead. Sliding doors at *B* permit work to be held under the blasts by hand, and glass windows at *C* allow the workman to watch the progress of the work without risk to eyes and lungs.

The sand runs from the overhead supply bin to the nozzles through the spout *D* to the gates *E*, which have screw adjustments and distribute the sand in a long, flat stream under the air nozzles *F* .An opening in the machine body at *G* is closed by a canvas curtain and permits work being placed on the endless belts. The exhaust pipes *H* carry off the spent air and fine dust, leaving the returned sand always clean and ready for use. These machines use from 12 to 14 oz. air pressure.

MEXICANS ARE NOT HUNS

To the honour of Mexico, it should be said that during the whole period of her troubles, the property of foreign investors has suffered but little injury. On the various mines, in the aggregate, machinery which has cost some hundreds of thousands of pounds, has been erected, and we have yet to learn that any of it has been damaged to any serious extent. In other words, the Mexicans have shown an example to the Huns which the latter may, in a day that is coming, regret they did not follow. The mines, therefore, are ready, one and all, to go to work, and some have already done so, though, as pointed out, conditions have not been wholly stabilized.—*Mining World*, London.

FIGURES HARD TO GRASP

The Entente Allies—excluding Russia and including only those British dominions which are self-governing, and only the United States proper—have 11,000,000 square miles of territory, 303,000,000 people and $495,000,000,000 of natural wealth. The Central Powers have 1,250,000 square miles of territory, 147,000,000 people, and $134,000,000,000 of national wealth. The Entente owe an aggregate debt of $69,000,000,000, which is about 14 per cent. of their total assets. The Central Powers owe $37,000,000,000, or 28 per cent., of their national wealth.

THE CEMENT GUN FIREPROOFS A MINE SHAFT*

By E. M. Norris

In the summer of 1917 it was decided to fireproof the tramway hoisting shaft of the Anaconda Copper Mining Co. at Butte, Mont. The shaft has three hoisting compartments and one pump compartment; it is timbered with 12 x12-in. fir timber, and is 2475 ft. deep. Subsidence and displacement of the surrounding country rock had produced exceedingly heavy ground, and had carried the shaft out of line, in several places, by as much as 2 ft. displacement. Constant repairing and realigning of the timbers had been necessary in order to maintain clearance for the cages. The most feasible method of fireproofing, therefore, seemed to be to cover the timbers with a coat of concrete applied with the cement gun.

The cement gun, which is operated by compressed air at ordinary mine pressures, feeds a mixture of sand and cement through a hose to a nozzle having a water connection. The mortar in fluid form is thus sprayed upon the prepared surface in thin layers, which can be built up to any desired thickness. The cement gun can be set up at any convenient point; satisfactory results have been obtained with the nozzle a distance of 500ft. from the gun.

The shaft was thoroughly overhauled and the timbers were put in the best possible state of repair. Between the 1000 and the 1400 levels, much loose ground lay against the shaft timbers on the north side; this was breast-boarded back and a 30-in. reinforced-concrete retaining wall was erected, leaving a space of 12 in. outisde the shaft timbers to allow for future movements of the ground. For convenience in handling men and materials, it was rearranged to concrete the auxiliary hoisting-first, using the cages of the main hoist to serve the cementing crews. The auxiliary cage was then available while the remainder of the shaft was being concreted.

A tight partition of 2-in. plank was erected between the auxiliary and the adjoining hoisting compartments, for beter protection of men riding on the cages. The application of concrete made this partition air-tight, which should prove a valuable feature of the fireproofing measures. It was considered necessary to guard against the spreading of fire in the timbers behind the concrete covering, as once happened in a Michigan shaft. A set of shaft lagging was therefore removed just above and below each station, and a concrete casing was built back to the walls so as to form an air-tight seal at these points. Another seal was made at the rear end of each station in a similar manner as illustrated.

CONCRETE REINFORCED BY METAL LATH

Experiments were made to determine whether reinforcing material was necessary to hold the concrete to the timber and, if so, what kind of material was best. It was found that if the timbers were wet down thoroughly the concrete would stick without reinforcement, but subsequent distortion of the timbers caused the concrete coating to shell off in large slabs. Tests of chicken wire, herring-bone metal lath, and diamond-mesh metal lath showed that all these materials made equally satisfactory reinforcement for the concrete coating, the only difference being the matter of cost. Chicken wire was the cheapest to buy, but the labor of nailing it to the timbers was much greater than with metal lath. After using several thousand square yards of each of these materials, it was found that the 27-gage diamond-mesh metal lath, 24 by 96 -in. was the most economical and satisfactory reinforcing material; it was also determined that 6-d wire nails driven two-thirds of their length into the timber, and bent over, made the best fasteners.

The comparments to be concreted were covered with timber bulkheads at each level and lathing was begun. The lathing crews consisted of six men to a lift, two or more lifts being lathed at one time, according to the number of men available. With the diamond-mesh material the rate of lathing was 225 sq.ft. per man per 8-hour shift.

Two cement guns, type N-L, were set up on mine trucks so that they could be pushed on the cages and moved from level to level as required. With an air pressure of 75 lb. per sq.in. it was found that 200 ft. above, and 75 ft. below, were the greatest vertical distances from the gun at which satisfactory work could be done with the nozzle. Where lifts greater than 275 ft. ocurred, it was necessary to set the guns on bulkheads in the shaft. The sand

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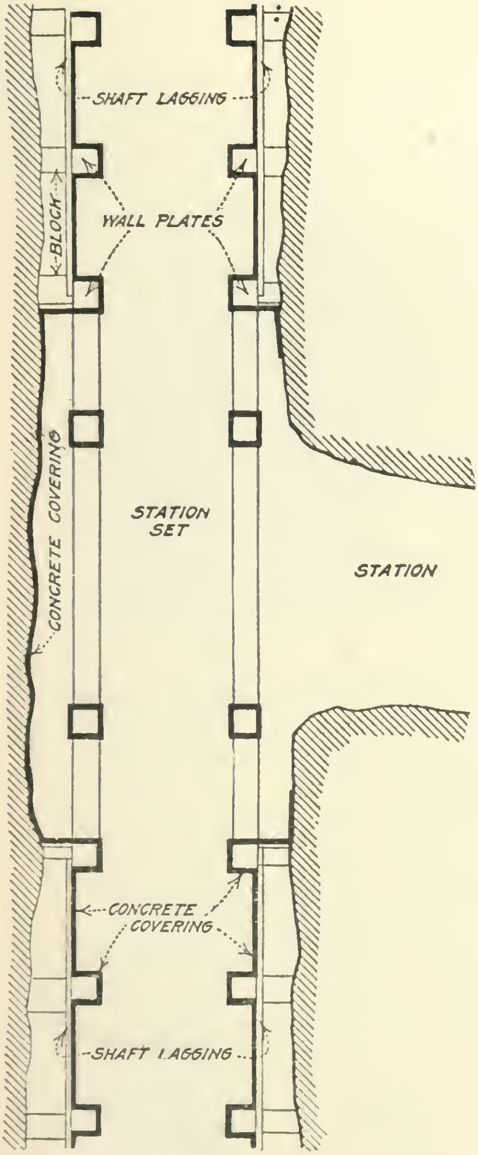
*Paper before the Colorado Meeting of the American Institute of Mining Engineers.



SECTION OF SHAFT

was dried, when necessary and screened through a ¼in. screen. It was then mixed with cement, on the surface, and put into old cement sacks for convenience in handling. It was found necessary to screen the cement also, as lumps blocked the discharge and caused frequent delays. Mixtures of 3, 3½, and 4 parts of sand to 1 of cement were tried. Where thin coatings (¾in. or less) were applied, the 3 to 1 mixture was the most satisfactory, as it went on more evenly and formed a tougher coating.

Each crew consisted of four men, two feeding the gun, and two on the nozzle. The nozzle-men worked from stage planks in the shaft and were provided with rubber gloves, safety goggles, and respirators. The surface to be coated was washed off thoroughly with water sprays. Concrete was applied in two successive layers ¼ in. thick. After the coating had become firm, it was sprinkled often enough to keep it damp for several days. It was found that a gun crew could cover from 800 to 1200 sq.ft. of surface in eight hours. Repairs on the gun were slight, wear being taken by the rubber liners. Nozzle liners lasted 48 hours, discharge liners about six weeks, and the cement hose several months. The shaft and station timbers were repaired and concreted from surface to the 2000-level in 94 days, 175,465 sq.ft. of surface being covered. The average number of men employed was 54, including superintendence and all surface labor connected with the job. Material used was 6102 sacks cement, 1500 tons sand, 165,495 sq.ft. of lathing, 2600 lb. nails and staples.

FIRE TEST SHOWS UTILITY

Four samples were prepared for fire test. Pine timbers 6 by 10 in. by 5 ft. were covered on all sides with lathing; three pieces were covered with chicken wire and one with metal lath. These timbers were then coated with ½ in. of concrete put on with the cement gun. Three of the samples were sprinkled daily for three days; the fourth was not sprinkled. After six days of hardening, the samples were placed in a large bonfire, until the concrete coating was heated to a dull red. The sample that had not been sprinkled shelled off with loud explosions, but the others were not affected. After 30 minutes the samples were pulled out and allowed to cool. Inspection showed that the only apparent effect of the baking was a slight charring of the wood on the edges, where the concrete had cracked while drying.

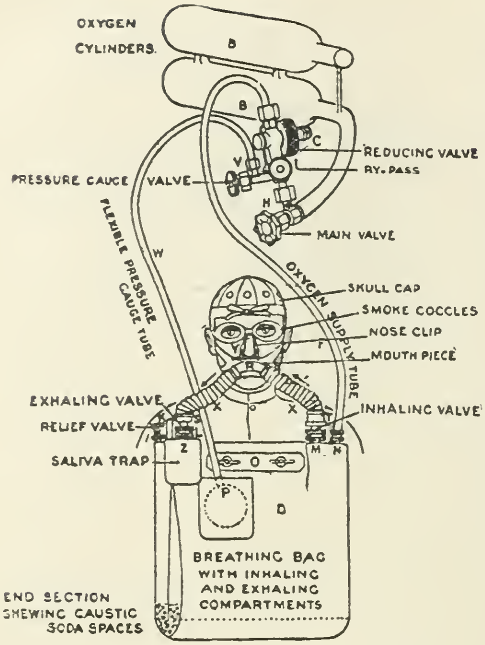


FIG. I

MINE RESCUE APPARATUS

In 1917 a committee was appointed by the Advisory Council for Scientific and Industrial Research to investigate the types of breathing apparatus used in coal mines. The report of the first year's investigations, which has recently been published, calls attention to certain serious defects in existing mine apparatus, and in the training of men in the use of such appliances. Passing to a description of the various appliances in use the report gives detailed particulars of each apparatus.

PROTO APPARATUS

The present day Proto apparatus, shown diagramatically in Fig. 1, has developed from the original design of Fleuss, whose first patents are dated 1879. The circulation is effected by the lungs of the wearer, breathing taking place wholly through the mouth, the nose being closed by a clip. The two cylinders B contain 280 litres of oxygen at 120 atmospheres. The reducing valve C allows a constant flow of two litres per minute into the breathing circuit. The oxygen, opening a light mica non-return valve at N, enters the breathing bag D. This bag is provided with a partition descending nearly to the bottom, and in the bottom is placed a quantity of stick caustic soda or coke nuts coated with caustic. Exhaled air passing through the saliva trap Z joins the incoming oxygen and passing through the caustic, which robs it of its CO_2, lifts a light valve at N, and enters the mouthpiece. The pressure gauge P is carried in a pocket in the front of the bag. The oxygen bottles are slung in a stout jacket, and repose in the region of the small of the back; the valves V and H are brought round to the left side where they are readily controlled by the left hand.

THE DRAEGER AND THE MECO APPARATUS

The Draeger apparatus is widely used in the United Kingdom, in America, and in Germany. The oxygen is supplied at a constant rate of two litres per minute from one or two cylinders C. Fig, 2, and by its passage through an injector I keeps the air supply in circulation without any dependence on the lungs of the wearer. The purifier is in the form of a cartridge carried in the chamber or chambers P, and can be changed whilst in a foul atmosphere. K is a cooler. The breathing bag is divided by a partition, through the centre of which is a small hole. The apparatus as a whole is rather severely criticised by the committee, which points out that the injector is liable to cause a negative pressure behind it, with the result that the external air may be drawn in through a leak. One death from this cause is on record.

The Meco apparatus resembles the Draeger fairly closely, and to both of them the committee's criticism of injector applies with equal force. One of the gravest risks with this device is said to be the danger of insufficient circulation, owing "to incorrect setting of the reducing valve, to the partial clogging

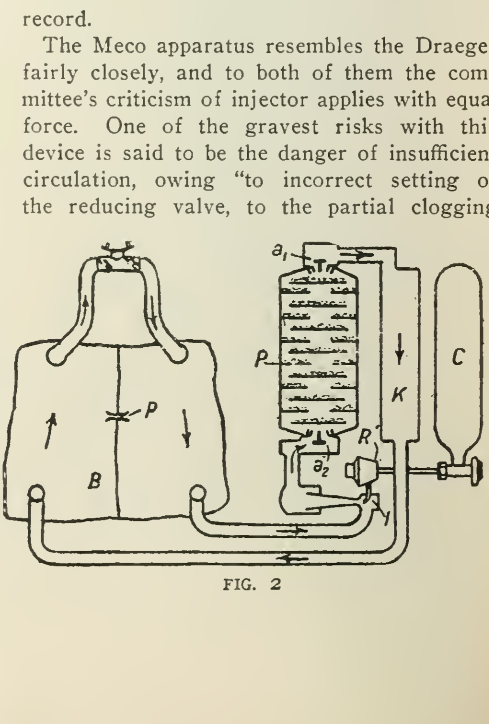


FIG. 2

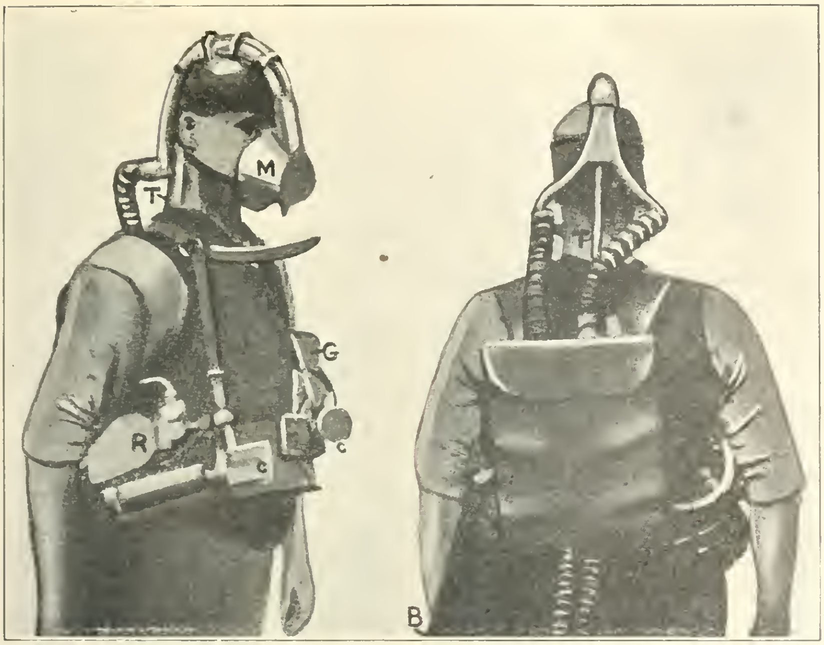


FIG. 3

of the secondary nozzle, to leakage from the circuit, to the accumulation of water or other material in the pipes, or to an increase in the resistance of the purifier. . . . When the wearer of an injection apparatus fitted with inspiration and expiration valves requires a greater air-volume than the injector supplies, he exhausts the inspirator bag and overfills the expiratory; breathing becomes more difficult, until eventually the inspiration bag flattens in mid-breath. The sensation of the lungs being choked in this manner is extremely distressing and is apt to produce panic, and such an occurrence has to be prevented at all hazards." To meet this difficulty the inspiratory and expiratory valves are omitted in the Meco apparatus, whilst in the Draeger apparatus either the two compartments are united by a small hole or the expiratory valve is omitted. The object in any one of these cases is to allow the wearer to re-breathe the exhaled air. "We look," says the report, "upon these expedients with the gravest suspicion," and in conclusion of the whole matter says "there is no gainsaying that the injector as an adjunct to breathing apparatus, is a grave source of danger. To do away with it entirely is the only satisfactory solution of the problem to which it gives rise."

THE WEG APPARATUS

This apparatus derives its name from the initials of its inventor, Sir W. E. Garforth. Side and back views are shown in Fig. 3. There are two curved oxygen bottles, which are carried at the sides of the wearer. They are connected by a narrow tube and contain 300 litres at 150 atmospheres. The two valves *c* and *c* are opened together; G is the pressure gauge, which is provided with a mirror which allows the wearer to take a reading by reflection. The breathing bag is carried on the back and the pipes from it are carried over the head to the mask. The most distinctive feature of the appliance is a delicate reducing valve R, which has a large diaphragm, and is adjusted to open during inhalation and close on exhalation, the object being to provide automatically for the varying oxygen consumption of the lungs. In recent designs two of these "lung governed valves" in series are provided.

LIQUID AIR APPLIANCES

In the first apparatus (the Ærolith) to use liquid air there was no purifier, the exhaled air was mixed with evaporated liquid air and breathed again; the formation of ice led to

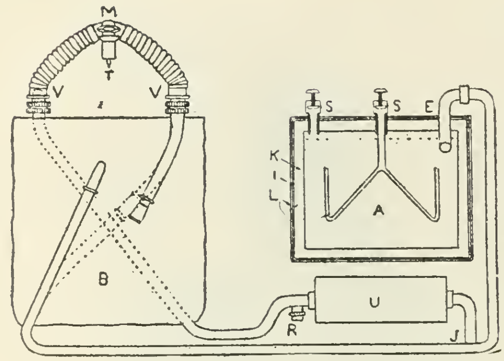


FIG. 4

excessive resistance in the earlier models. In the Aerophor a purifier is provided—see U in Fig. 4. The liquid air container A is carried on the back. It is a metal receptacle packed with asbestos wool and is filled through a central opening by pouring in eight or ten pounds of liquid air from a large Dewar flask. The receptacle is well insulated but receives enough heat to cause gentle evaporation. At first more air is given off than the wearer needs; some of it then passes by the branch pipe, J, and entering the purifier escapes by the valve R, through which exhalation also takes place. Later, when the evaporation is less active R closes and the exhaled air traverses the purifier, and joins the new air on its direct course to the breathing bag. Owing to the early excess, it is possible to couple a pipe and mouthpiece to R and thus supply two men from one apparatus for two hours or so. Either a mask, or a mouthpiece and nose clip may be employed.

THE TISSOT AND GIBBS' APPARATUS

In the Tissot appliance which is largely used in the French mines and by the French army, both the breathing bag and the purifier are carried in a case on the back. This is the only apparatus, in which a liquid potash solution is employed. The lye is made just before use. The report draws attention to the disadvantages attaching to a liquid purifier and observes that as applied in this apparatus "it is not particularly effective in abstracting CO_2." To Dr. Tissot belongs the credit of first controlling the oxygen feed by means of an adjustable reducing valve manipulated by the wearer. The automatic relief valve on the breathing bag is novel, in that is is a slide valve operated by the inflation of the bag.

The Gibbs' apparatus, American, closely resemble the Tissot, but the purifier consists of caustic soda cast upon gauze. Garforth's principle of automatically controlling the discharge of oxygen according to the needs of the wearer is utilized, but instead of the discharge valve being operated by pressure difference, as in the Weg, it is opened mechanically by the partial collapse of the breathing bag, which is of the bellows pattern and is borne on the back. The apparatus has several ingenious features and is well spoken of in America.

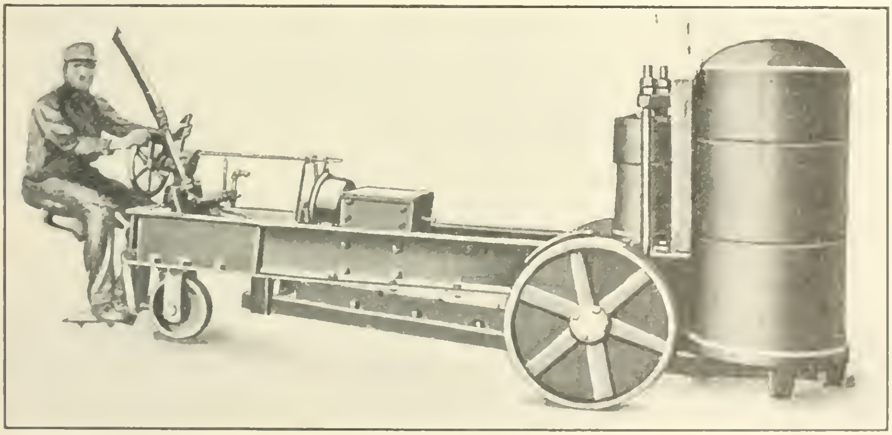
THE PNEUMATOGEN

In this apparatus the exhaled air is regenerated by passing through cartridges of oxylith (potassium sodium peroxide). This substance is attacked by CO_2 and watery vapour with the liberation of about the same volume of oxygen as the CO_2 and water contain. Whilst the apparatus has the advantage of small weight the development of excessive resistance and heat has been inimical to its success.

RECOMMENDATIONS

The second part of the report is given up to a critical examination of the different appliances examined and to recommendations. After alluding to the fact that failures of rescue apparatus are due to preventable causes, the report proposed that no apparatus should be employed without official approval, and that an inspector of Rescue Training and Organisation should be appointed. The causes of failure are then discussed in detail and may be briefly enumerated. (1) A dangerous proportion of CO_2 may accumulate in the air breathed. The reporters are strongly of opinion that "a purifier should be so constructed that it will outlast the oxygen supply." (2) The oxygen supply may fall short—generally owing to leakage. (3) The oxygen percentage in the air breathed may fall dangerously low. This risk may be minimised if both the breathing bag and the wearer's lungs are washed out with pure oxygen at the start, a course which the committee recommends. (4) The apparatus may leak, allowing poisonous gasses to enter. The chief source of danger is a leaky mouthpiece. (5) The breathing bag may become so empty that a full breath cannot be drawn from it. (6) The apparatus may fail owing to excessive resistance to breathing. (7) The temperature of the inspired air may become excessive. (8) The wearer may be overcome by a rise in his own body temperature. (9) The apparatus may fail through faulty construction. Under this last heading, a great number of details are discussed, and in the first place the recommendation is made that "the existing types of helmet and face mask be abolished in so far as self-contained apparatus is concerned." They suffer from the defect that they cannot be made air-tight, particularly on men with hairy faces or sunken cheeks or cheeks that draw in much on inhalation. "The mouthpiece is the only attachment independent of such consideration, and the only one on which reliance can be placed." Amongst other recommendations with which we need not deal we notice that an official requirement as to oxygen purity and that compulsory analysis of oxygen are advocated.

The above we reproduce, with some abbreviation, from *The Engineer,* London.



AIR OPERATED TRUCK FOR MALLEABLE IRON OVENS

The illustration above shows a truck built by the Brown Specialty Machinery Company, Chicago, for charging stacks of castings into malleable iron annealing ovens. It is operated by compressed air supplied by a hose connected with the foundry air service. As will be seen, the main frame consists of two steel channels from which are suspended the 4-inch steel elevating and lowering arms that are equipped with removable cast steel tangs for picking up the sacks of charging boxes. These tangs may be replaced readily when worn. The arms are raised by an air cylinder controlled from the operator's seat. A reversing air motor drives the truck, through a set of reduction gears and a standard motor truck differential, to pinions engaging in the internal gears on the driving wheels. The truck is guided by a standard motor truck steering worm, so arranged that the truck can turn in its own length. The air hose is suspended overhead. The air consumption is only 80 cubic feet per minute and the operating speed 90 to 120 feet per minute.

COMPRESSOR TROUBLE—COMPRESSOR NOT TO BLAME

We use compressed air to a very large extent. One of the compressors is in my department and has been a source of endless trouble and expense. At the time I got to work on it it was a sorry-looking outfit. The pulleys on the jackshaft had been lagged with belting to help them pull and to make the belts run to the center. The belts were really just some pieces of greasy hides about of an even width, and black with oil, belt dressing and rosin. One of the pulleys had been partly wrecked by the heavy work and the grease, and two piles of the rim from either side had been torn off.

Here was a chance for a little study. Pulleys don't act that way in general, and belts don't get greasy unless the oil is allowed to get to them. It was estimated that it took 40-

h.p. to run the compressor, and the lineshaft from which it was driven had 75-h.p. hung on it and was driven by a 50-h.p. motor. Add the compressor to that, and we had over 100 per cent. overload. Now, if the load had been arranged in good shape the result would have been the stopping of the motor and the blowing out of a fuse, or else the belts would have run off; the latter is what happened.

We are blessed (?) with a departmental supervision of mechanics, and if it were not so expensive it would really be funny. About the time I got to this compressor trouble there were some eight or nine officials to pass on the matter, and the last one that I got my instructions from simply told me to see what the trouble was, and he added: "By all means get the compressor going."

About the first thing to do in a case of this kind is to check up. See if you have on hand what all the elaborate reports say you have; and then see if what does check up is of the right size. The first day I was in this shop was the last day they had been trying to run this compressor. I usually use my eyes and take stock of my surroundings, and one of the things I saw was that one of the belts was fluttering very much while they were trying to run the machine.

There are a few millwrights who do not know that in the case of a double-belted drive both pulleys on the driver and driven must be of the same size. The first thing I found on this drive was that the driving pulleys on the jackshaft were ¾-in. different in diameter. That accounted for the fluttering of the belt and the fact that one pulley was torn loose in trying to run the belts.

After a couple of days arguing with the "man higher up," I got two new pulleys of the same diameter and two new belts, and the boss took my figures on the power needs and let me put in a separate motor to drive the compressor—and then the old trouble about the greasy belts turned up. The machine had a splash system for oiling and the oil ran out on one of the journals, down the hub of the pulley and went all over everything in a shower. That was a defect in the oiling system of the machine, which was corrected by putting a spring near the hub and holding a leather point at hub to catch the drip and turn it down into the oilpan. It was crude but effective, and now the compressor is running as it was intended to run, and without the oil bath that has been destroying belts and pulleys.—*R. W. J., Woodworker.*

DRILLING BOULDERS WITH JACKHAMER DRILLS

In overburden stripping on the Mesabi Range when the steam shovel encounters boulders too large to be loaded, they are rolled to one side of the cut and left until drilled by "single jackers." These "single jackers" work on contract and average about 15 ft. per shift in granite, states Mr. L. D. Davenport in the *Engineering and Mining Journal,* from which this note is taken. Blasting is done by the company powder man, using 60 per cent. dynamite. When a large boulder is partly uncovered in the bottom of a cut and projects so that it interferes with the shovel track or the jack-arms, there are several ways of removing it. One practice, formerly common but now seldom used, is to "bulldoze;" that is, to place 25 to 75 lb. of dynamite on the boulder and blast. Needless to say, this method frequently injured the shovel. Often a small "gopher" hole can be dug under the boulder on a side away from the shovel and charged with black powder. When blasted, the ground will frequently be loosened enough to allow the dipper to roll the boulder to one side. Some stripping contractors have provided one or more drills of the jackhamer type on each shovel. Air is supplied from an air pump or the compound pump on a locomotive, and the boulder is block holed.

HAIR MATS CURE BAD ACOUSTICS

Present day fireproof construction often tends toward faulty acoustics; the hard, flinty surfaces that form the walls and ceilings catch the sound waves and throw them back multiplied and magnified. A method of eliminating this trouble has been developed recently. This consists of the application of a scientifically constructed mat of woven hair to the ceiling and when necessary to other points. The millions of minute interstices of the mat absorb the sound waves in both direct and reflected action. The mat is covered in such a way to give the appearance of a pleasing and harmonious finished surface, without injuring the power of absorption. It in no way detracts from the architectural appearance or the decorative scheme.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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THE RAISING OF THE ST. PAUL

In these days, when events of world wide moment and interest crowd so closely upon each other as to constantly crowd the chronicler, the raising of the steamer St. Paul, of which we give a brief account in this issue, must slip into the past with much less notice than it deserves or than it would normally receive in times of peace. To those who give the achievement the slightest attention it speaks for itself as to the difficulty and magnitude of the problem, and of the resourceful ingenuity, the perseverance and, incidentally the expenditure which brought final success.

The sinking of such a ship, the manner of her sinking in the quiet harbor, the position in which she lay, and the oozy mud which engulfed her were all without precedent. It will be seen that after the conditions had been minutely investigated the problem involved was two-fold: first, to bring the ship to an approximately upright position, and then to cause her to float, the former being by far the most difficult part of the task. Words are all too weak to tell of the constant work of the divers, work of the most difficult and dangerous character, and deserving of vastly more individual recognition and recompense than is practically possible. The restricted space between the piers made it necesary to roll the ship in her bed of mud without at the same time causing her to slide laterally, and to secure this the ingenious device of the A frames provided most effectively. These A frames, with the pull of the hawser at the apex of each, doubled the leverage for rolling the ship over, while the effective lateral force upon the hull was minimized or mostly avoided by the angle of application. We may believe that there was little of guesswork or of cut-and-try in this operation, but that the work to be done and the forces applied were subjects of careful computation.

We feel especially warranted in speaking of the successful raising of the St. Paul on account of the important and most responsible part which compressed air played throughout the operations. The divers were busy on the job all the time and the air was constantly busy with them. The divers used jets of air, we are told, in blowing away the mud which interfered with some of their operations. The oxy-acetylene torch was used under water for cutting metal, and at depths greater than ever before encountered. The oxygen used is, of course, a compressed air product, coming to us in the processes of manufacture by the way of liquid air. Compressed air was used also for controlling and determining the body of water in the forepeak of the ship during the refloating operation to maintain the longitudinal equilibrium.

The responsible engineers employed upon this work deserve high appreciation and unstinted praise, and it is to be hoped they receive also commensurate pecuniary recognition. The naval world is to be congratulated upon its acquisition of knowledge of the ways and means of marine salvage, and finally we may inquire how all this could have been done without the aid of compressed air.

A PERMANENT FILE FOR MINING RECORDS AND REPORTS

The exigencies of the war have brought out the necessity of having in Washington a permanent file containing detailed information relating to mines and mining companies, information that is not now available in any library but is needed by the Government in solving many problems relating to the betterment of the mineral industries. The Bureau of Mines, therefore, has undertaken the establishment of a file in which it intends to place not only data published in the annual reports of directors or mine managers to stockholders, but also reports of consulting engineers and the information supplied by mining companies in reply to questionnaires submitted to them. The reports of consulting engineers and any mining reports that the author or the operator wishes to have considered confidential will be so regarded; those that may be published later will bear a stipulated release date such as the author or operator may indicate.

In order that this information may be collected as rapidly as possible the Bureau of Mines invites mine operators, consulting engineers, and others to forward copies of reports that they may make on any mining property, these reports to be filed permanently with the bureau at Washington. Also the bureau asks all mining companies that issue an annual report to kindly favor the bureau with a copy for its files.

FOR CLEAN AIR FOR PNEUMATIC TOOLS

The following "Standard Practice Bulletin," issued by Division of Steel Ship Construction, United States Shipping Board Emergency Fleet Corporation, may be regarded as exceptionally good information and advice in the line indicated, and of course applicable wherever compressed air is used.

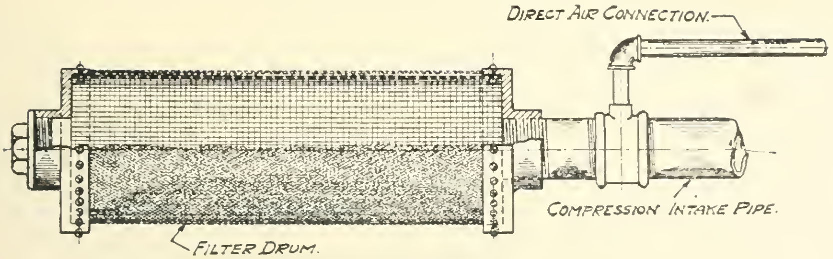
In view of the rather alarming rate of deterioration of air tools in shipyards under present operating conditions, and the inability of tool manufacturers to cope with the increasing demand for new tools and repair parts, it is important that very prompt and careful consideration should be given to every effective means of tool preservation.

A great deal has been said concerning the care and lubrication of pneumatic tools, inspection repairs, etc., which are of prime importance and should be followed up with increased emphasis, but for some reason little has been said, and practically nothing is being done, in the majority of shipyards, along the line of providing a clean air supply for the tools.

One of the simplest and most logical steps in an effort to prolong the life of tools, as well as the compressing equipment, would include a proper cleansing of the air supply at the compressor intake. Air taken in around the average manufacturing plant is anything but clean, even though the inlet is favorably located, and it is certain that the wear of pneumatic tools is very rapidly increased by dust and grit carried in the air, even when the tools are properly oiled.

Cloth filter screens, if properly designed and handled, will clean the air to a very large extent and can be made to serve the purpose in a very satisfactory way. The larger the filtering area, the closer the grade of cloth that can be used, and the more perfect the filtration. A very open cheese cloth, for instance, placed over an inlet strainer having not more than two or three times the area of the compressor suction pipe would do very little good while a closer woven and more substantial cloth placed over a much larger area will admit the air at a lower velocity, with no more resistance, and will clean it very much more thoroughly.

Careful tests made by the Standard Practice Branch of the Emergency Fleet Corpora-



FILTER FOR INTAKE AIR

tion show that air will pass through a light grade of unbleached muslin (common unbleached cotton cloth) at the rate of 100 cubic feet per minute per square foot of area, when subjected to a suction pressure, equal to ¼" static head of water, or the equivalent of approximately 1/100 of a pound. On account of the pulsating action of the air entering a compressor suction pipe, a light cotton cloth filter should be based on a velocity of not more than 1 foot per second or 60 cubic feet per minute per square foot of surface.

While the arrangement of a Compressor Intake Filter will depend, more or less, on the particular location and surroundings, it will always be possible to extend the suction pipe outside of the building in the form of a drum, constructed of heavy wire netting, as indicated by the accompanying sketch. The filter cloth can be placed around the drum, or series of drums, where large area is required.

If a supporting layer of poultry wire is secured around the outside of the cloth a large measure of cleaning can be very conveniently accomplished by admitting a sufficient volume of high pressure air directly into the intake pipe and reversing the flow through the cloth, at intervals when the compressor is not in operation.

An intake of this type should be protected by hood or shelter to keep the cloth dry.

A plain "U" tube draft gauge conveniently located and connected with the suction drum would indicate the resistance imposed by the cloth as it becomes clogged and call attention to the necessity of cleaning.

Air washers similar to those used for cleaning air for the ventilation of buildings should provide an ideal means for completely removing all dust and dirt from a compressor plant air supply.

While the humidity will be increased in the air before compression during certain weather conditions. It is interesting to note that no practical disadvantage will result, for the following reasons:

Air having a relative humidity of 15 per cent. or over, when compressed to 100 pounds and cooled to its original temperature, is fully saturated.

Since the air approaching the tools is usually saturated when no washer is used, the only difference will be the quantity of water condensed in the pipes.

The quantity of water condensed in the pipes under the present conditions, gives serious trouble if not properly provided for by the use of separators in the distributing system and an even greater quantity will give no trouble whatever if proper provision is made for its collection and disposal. Hence the difference, except in very dry weather, is a matter of quantity of water to be handled in the pipes and not a difference in the final humidity of the air at the tools.

If after-coolers are used, to precipitate the moisture at the power house after compression, the question becomes one of quantity of water precipitated and, except in very dry weather, conditions in the distributing lines will be identical either with or without air washing.

A study of the pneumatic tool situation at one of the large shipyards showed that the foreign matter carried in the air was of such a nature and extent as to practically preclude the use of the small wire gauze strainers, which belong in the air gun connections, on account of too frequent stoppage. The operators arbitrarily remove the strainers on account of the delays which they cause.

The repair room records in this plant show that more than 50 per cent. of all air tool repairs consist of cleaning air parts and working parts affected by the dirt carried in the air. In like manner, a large percentage of compressor troubles, so far as the air cylinders and valves are concerned are directly caused or aggravated to a large extent, by the dirt.

There is every reason to believe that a proper cleansing of the air supply, together with separating tanks or chambers, located near the distributing headers for the removal of water, pipe scale, etc., (see Bulletin No. 4), will do much to relieve the rapid deterioration of air tools.

The emergency Fleet Corporation will be glad to co-operate with shipyards interested in this subject, through its Standard Practice Branch and to furnish more specific designs and information upon request.

OXY-ACETYLENE AND ELECTRIC WELDING IN RAILROAD SHOPS*

By A. F. Dyer.

Under the present hampering conditions both the electric and the oxy-acetylene processes have proved of great help in railroad repair shops. Seven years ago the Grand Trunk employed one man as an acetylene welder; now instead of one man we employ eighteen and often work overtime.

The low pressure acetylene gas system is used and the entire shops are piped for the acetylene, every other repair pit having a drop connection. In roundhouses we use Prest-O-Lite dissolved Acetylene in cylinders, which saves the expense of a generator and piping where the process is in use only occasionally.

Both the electric and the oxy-acetylene methods of welding have proved themselves fit to be ranked among the greatest time and labor savers introduced on the railroads for a long period. For instance, not long ago a locomotive with a broken frame would be held in the shops for several days, as it would take some time for removing the frame, having it welded in the smith shop and then machined and replaced. Now a frame 4 in. by 5 in. can be cut and welded in less than 14 hours. Frames, when worn by brake gear and stays, are built up and worn holes are plugged and welded instead of reaming them out to a larger size and thereby weakening the frame.

The present price of tool steel demands that none shall be wasted; therefore we use it down to the last inch by welding it to tire steel. Twist drills, taps and reamers, when broken near the socket end, are welded and put into use again. For this purpose we use either the electric or the gas process, but in both cases we use vanadium steel filling rods, as we find this gives the best results. Spokes of driving wheels are welded and flat spots on tires have been successfully welded when it was necessary to do so.

Up to the present time we have not had much success welding cast iron with the iron electrode although with the carbon a fair job can be done, but the gas is unquestionably the best for any of this work. We have successfully welded with oxy-acetylene, steam shovel engine frames and cylinders by welding in patches of cast iron where worn or broken. When our contract for shells was completed and the lathes that were used for this purpose were being overhauled, it was found that most of the V-slide beds were worn by the tool carriers. These were built up by the oxy-acetylene process, which saved machining the beds down as much as ⅜-in. in some cases.

In regard to boiler work, most of the welding is done with the iron electrode using a mild steel or Swedish iron as a filler. It is found that the electric process localizes the heat more than the gas, though it is the writer's opinion that the gas makes a closer and neater weld as all welds made by the electrode are more or less porous unless they are hammered. When patching a firebox it is better whenever possible to apply quarter or half side sheets in order to get the weld out of the fire. However well a patch is welded, it generally gives out in from twelve to eighteen months' service, and the same applies to cracks, whereas the quarter or half side sheets should last as long as the firebox.

When a nest of small cracks is found round the staybolts, the bolts are removed and the holes countersunk and welded. This method has been found to be very successful. Corner patches are welded by running the patch into the tube or back sheets, as the case may be, at the same time removing the flanges. If it is decided to do away with a number of tubes, plugs are welded in the holes. The holes are countersunk and the plugs are punched by a countersunk die which gives them the proper bevel for welding.

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*Condensed from a paper before Canadian Railway Club.

Superheater flues are being successfully welded to the tube sheet. The operators I am connected with prefer to have the flues belled and water in the boiler. This keep the tube sheet from heating, especially around the smaller tubes. The tubes are set in with copper ferrules set back 1/32 in. and the flues are belled out 3/16 in. to 7/32 in.; the small tubes, 3/16 in. The sheet is roughened all around the tubes and flues, and the oil is then burnt off with the oxy-acetylene flame and tubes and flues welded in with electrode, using ⅛ in. mild steel or Swedish iron. The latter is preferred if calking is needed.

A sample of an average day's work is as follows, for a gang of 12 men:—

14 rivet holes in smoke-box and 4 peg holes in foundation
10 tube holes in upper portion of firebox tube sheet.
2 air pipes which were worn through.
In the tool room:
1 ratchet for jack (2-teeth replaced).
1 gear spindle built up.
1 chuck screw, key end built up.
1 boring shaft built up from 2½ in. to 2⅞ in.
2 tool holders, rebuilt.
1 air hammer handle repaired.
6 teeth in lathe gear, built in.
1 cone, small end filled up solid.
2 1¼ in. holes in top rail of frame filled up.
4 cracks 18 in. long in right side sheet welded.
14 bottom tube holes welded up.
2 washout plug holes built up for re-tapping
Cut out frame for welding and started welding same.
Welded bushes in pony truck stays
Cut out 3 sets of boiler tubes.
Cut out one set of superheater flues.
Build up calking edge of first hole.
Heated corners of tube sheet for closing.
Welded broken superheater damper bracket.
Built up reversing lever where worn.
Built up 2 side rods where worn.
Cut out 48 flexible staybolts in firebox.
Welded 2 cracks in throat sheet.
1 broken flange of air brake cylinder.

In addition to this list two men are engaged continuously on cutting around the shops.

For cutting steel and wrought iron the oxy-acetylene process has practically no competitor it being impossible with the carbon point to cut as fast or as fine and neatly as with the gas torch. For scrapping fireboxes and frames, the carbon point is cheaper to use if time is no object and labor is cheap.

The foregoing examples illustrate only a very small fraction of the uses to which the two methods of welding and cutting are being put in locomotive repair and machine shops, and fresh uses are being found for it every day. No roundhouse should be without an oxy-acetylene outfit, both for repair work and as a part of the wrecking outfit, and all large roundhouses should have both processes, as they would would pay for themselves over and over again.

In concluding, I would state that though there are many different opinions as to which is the best process, no shop is complete unless it has both equipments, although the gas has really the widest range.

Welding should not be treated as a side line of the machinists' or boilermakers' business, but should be treated as a trade in itself, as it really is, for it needs the entire concentration of a man's mind, careful study, plenty of practice and a conscientious man to make a welder.

Wherever possible a separate building or suitable space should be provided for bench work, and should be equipped with a suitable furnace for heating and annealing castings. There should also be plenty of floor room for charcoal fires for preheating cast iron jobs before welding.

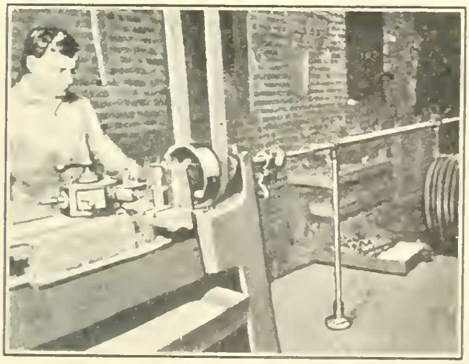


FIG. 1

AIR FEED ON TURRET LATHES

The compressed air feed for turret lathes as shown in Fig. 1, is an entirely automatic, yet very simple, effective and inexpensive device. The illustration shows a Bardons & Oliver machine at work in the Columbus Brass Co.'s shops at Columbus, Ohio. This concern has used the air feed attachment with satisfaction for nearly eight years. The rods being machined are about 14 feet long.

Directly in line with the lathe spindle, extending to the rear, is a piece of Shelby tubing, large enough in diameter to allow easy

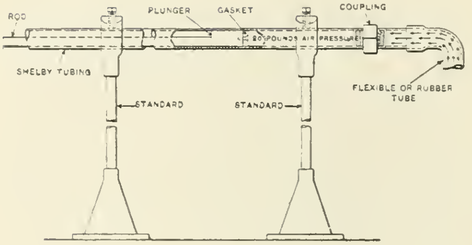


FIG. 2

movement for the rod, and extending about a foot beyond the end of the rod when it is held in the chuck. The tubing is supported by standards as required, and equipped at the rear end with an easily detached air coupling. One other part is required—a cold-rolled steel plunger, to one end of which a leather gasket is attached. The plunger fits loosely in the tubing, while the gasket, of course, is tight. The operator loads the lathe by pushing the rod through the tubing into the chuck, sliding in the plunger with the gasket outward and quickly coupling the air tube to the Shelby tubing. He then turns on the air, producing a constant pressure on the rod of twenty pounds per square inch, which forces it forward until it reaches the stop on the turret head. The rod is then chucked and ready to be machined.

To advance the rod, preparatory to starting a new piece, the operator simply releases the chuck, keeping the stop in its proper position, and the rod immediately advances to it. The lathe here shown is also equipped with an air chuck; hence the stock is both held and fed by air.—*Machinery.*

(Continued from page 8936)

work under fire in their cutting work, it is necessary to have additional trained men to take the place of those wounded or killed. As the work provided is extremely irregular, the welders can be employed on other work during quiet periods.

Department of Electricity.—The department of electricity employs oxy-acetylene welding mostly in connection with cracked frames of gasoline motors used to drive dynamos for generating electricity used at and near the front. On account of shell fire it is found impracticable to bring electric current from generating stations situated well to the rear, and therefore gasoline motor generating sets are employed locally. Two men and one set of apparatus take care of all the work necessary for an entire army of 200,000 or more men.

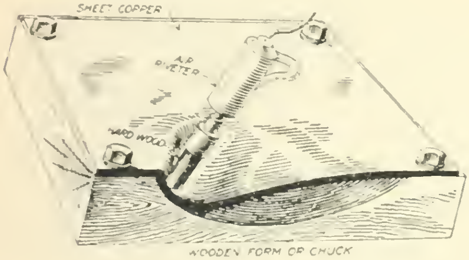
Railroad Work.—Narrow-gauge railroads, about 2 feet (60 cm.), are extensively used in hauling guns, ammunition supplies, and all kinds of material from the terminals of the broad-gauge railroads to the front, such narrow-gauge track often going to within 400 yards of the front trenches. The locomotives used are of two kinds, steam and gasoline, the former being used farther to the rear, while the gasoline motors are used near the front, where they are operated at night. The cars are usually of steel and hung very low. This equipment is broken and damaged through actual hard wear and frequently also by shell fire. It is here that the oxy-acetylene process is used not only for welding broken parts, but also for cutting away parts badly damaged by shell fire. At the repair yards two sets of apparatus, one stationary and the other portable, are provided so that large pieces, such as cars, etc., which can not be brought into the welding hut, can be repaired in the open.

The process is of great value in this work as a locomotive, either steam or gasoline, may be so badly damaged by shell fire as to make replacement of the parts impossible, when it can, nevertheless, be repaired by welding. For example, one motor locomotive inspected had a cracked frame, a broken oil inlet pipe, and a broken cross member, involving the welding of steel, brass, and aluminum. This work was easily repaired, whereas otherwise it would have involved either the scrapping of the locomotive or the shippnig of the whole machine to a main repair shop located perhaps 100 miles to the rear. The repairs were actually made within 6 miles of the front.

On a front of about 60 miles there are three posts or repair yards for this class of work, serving about 250 locomotives in all. Each post has two sets of apparatus and three experienced men. About 100 cubic meters of oxygen are used monthly at each post.

These figures are given for a front which was extremely inactive at the time. A much larger use could be made of the process were equipment and men available. One set of welding apparatus and two men should be provided for from 40 to 50 locomotives and their cars or trucks.

Forts.—Oxy-acetylene welding has been found available in connection with repair work at forts, such as those surrounding Verdun. Broken cupolas, etc., can be repaired and débris cleared away by this process. At present one set of apparatus with two welders using six cylinders of oxygen and six cylinders of acetylene per month are employed to take care of all the forts around Verdun. A larger equipment than this would be desirable but can not be supplied at present.



FORMING SHEET-METAL WORK WITH AIR HAMMER

By Harvey Feldmeier

I recently had occasion to spin some large copper sheets in making dished heads for special tanks. This involved the making of spinning chucks and improvising a lathe consisting of a wooden frame, a spindle, spindle bearings and pulleys.

The actual spinning operation is simple, but when only a few pieces are to be made and no lathe or means of swinging a spinning chuck is available it is not often convenient. In such cases it is customary to raise the sheets by hammering them on a wooden block.

It occurred to me while watching a workman pound out a copper sheet in this way that an ordinary pneumatic riveter, if fitted with a simple socket so as to hold a wooden block, or mallet head, could be used for the purpose.

This was quickly rigged up and a test made by taking one of the spinning chucks, fastening the sheet over it, the sheet being held down by bolts at the edge, and by using the pneumatic riveter with the wooden head it was found that the metal could be easily forced into the chuck. This method may be old, but it was new to the writer, and seemed to open up a new way of embossing, or "raising," sheet metal, especially copper, without the necessity of having expensive tools.

After making up quite a number of tank heads from tinned copper in this way, we found that those which had been raised by the pneumatic-hammer process were much smoother and more perfect than those which had been spun, because there were no abrasions of the surface and no spinning marks. For raising sheet metal to regular shapes this would seem to offer a promising field.—*American Machinist.*

A PNEUMATIC "BOLTER-UP"

A mechanical bolter-up, which, according to *Over the Top*, promises to be a great aid to shipbuilders of America, has been invented by David Martyn, of the Vancouver steel yard of the G. M. Standifer Construction Corporation.

In shipbuilding thousands of temporary bolts are put in to draw up and pull the plates and bars together, before riveting. Those put in through the keel and shell at the bottom of the ship are tightened by workmen with uplifted arms. In that position it is not possible for a man to exert his full strength, because with one hand he holds the wrench on the nut, and with the other hand, he either pulls, or pushes the wrench.

When doing this he must use every care to prevent injury to his hands. Very often the wrench slips off the nut and his hand comes foul of one or more bolts and nuts already in place.

Mr. Martyn sought to make the work easier, to get more done, and eliminate the chance of injury. This he has accomplished in a simple and effective way. The workman does not lift the wrench and hold it in place. It cannot slip off. The energy is imparted at such a point that the workman's hands do not come near the other bolts and nuts.

The man may pull, or push, fearlessly and it was demonstrated that bolts could be pulled asunder every time without risk of injury to the person, while the machine showed no signs of yielding.

Martyn's machine will be made in three sizes, or rather in three lengths, for each will have sockets to fit ¾, ⅞ and 1-inch nuts.

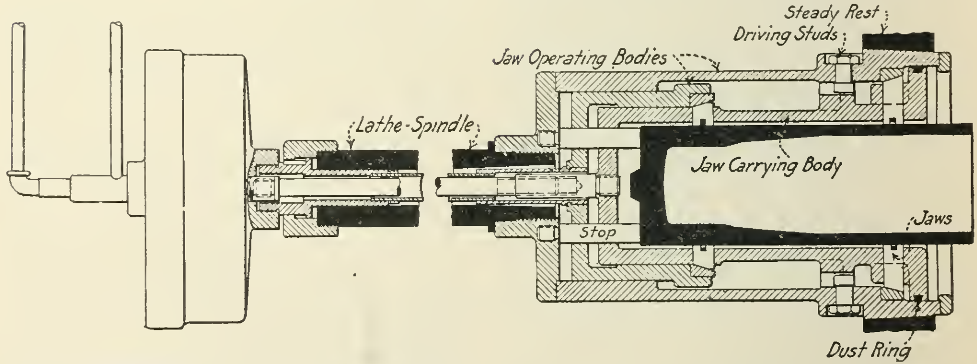
Its construction is simple and very readily understood. First, there is a steel tube about 36 inches long, fitted with a cap at its bottom end; into the tube is fitted a suitable valve; to this is attached a compressed air hose.

Into the tube is placed a square piston rod, having a piston attached to its bottom end. At the top of this rod, sockets which fit the different size nuts may be placed.

Resting on the top of the tube is a piece of steel, hexagonal in shape, which has a square hole in it, to fit the square piston rod. A lever, or wrench, having a hexagonal hole, fits over the steel piece just described.

To use the machine, the workman attaches the compressed air, then opens the valve. The air forces up the piston rod and its top end, on which is the socket, is guided over the nut, onto the bolt to be tightened. The lever is turned round until the nut on the bolt is screwed up and the plates drawn together. To remove the machine the operator turns off the air.

The "bolter-up" also is an air jack, for the application tends to force the plates together, before tightening the nut, and at that time. By using it the plates, or bars, are brought firmly and close together, which insures good riveting and excellent workmanship. At the same time it is computed that by the use of this machine one man can do the work of five.



AIR OPERATED CHUCK FOR SHELLS

The cut above shows the essential feautres of a special air operated lathe chuck for centering and holding war shells to be machined on the inside. The lathe spindle is necessarily hollow and the air pressure is transmitted through it, the ordinary shop air pressure of 80 or 90 lb. being sufficient for the service. The chuck jaws are separate and operate independently for each end of the shell. When the air is released the jaws are entirely withdrawn, having the cylindrical interior of the chuck without any obstruction to interfere with the insertion or removal of the successive shells. A dust ring is provided for keeping the operative parts clean. A special chuck is of course required for each size of shell and the chucks are made from 3 in. dia. upward and corresponding lengths, by the Production Appliances Co., 14 South Jefferson street, Chicago.

HEALTH OF THE ARMY

During the Mexican War, the annual death rate from disease among our troops was 100 men out of every thousand. During our Civil War, the rate was as high as 60 out of every thousand. During our Spanish-American War, it was 25 out of every thousand. Now the Surgeon General's office reports that among our troops at home and abroad, the annual death rate from disease fluctuates from less than 2 per thousand to slightly more than 3 per thousand.

This is an incredible record. The best of all previous performances was in the Russian-Japanese war, when the annual death rate from disease among the Japanese troops was 20 per thousand. Our present rate is about one-tenth of that. The annual death rate from disease among American men of military age in civil life is 6.7 per thousand. Our army rate is about one-third of that. And the miracle has been achieved not by any one medical discovery or precaution, but by a campaign of administrative vigilance that has used every means to protect and promote and assure the health of millions of men.

NOTES

Government officials are now considering a plan to clean all material used in the manufacture of balloon fabric by a vacuum process. It is said that much of the material is rejected by inspectors because of dirt which has been worked into it in some manner.

The volume of natural gas from which the output of natural-gas gasoline in 1917 was recovered is estimated to have amounted to about 429,000,000,000 cu. ft., and the average recovery of gasoline per thousand cubic feet was about one-half gallon.

Indicative of how the logging industry of the Pacific northwest is undergoing an evolution especially with regard to the saving of man power is the fact that at the tenth annual session of the Pacific Logging Congress, at Portland, December 5 to 7, one of the important features will be a discussion of the use of compressed air in the woods. With the reality of the electric and gasoline donkey, operators want to go a step farther and utilize compressed air to advantage in sawing the fellod log in the woods.

The Norfolk and Western Railway recently had in its possession several carloads of corn that was heating on acount of excessive moisture. In order to preserve it, a hose and pipe was connected to air pressure tanks and compressed air at a pressure of from 70 lb. to 90 lb. was blown through the corn at various points in the car. Before the operation, the temperature was 107 deg.; during the hour that the operation was being conducted it was reduced to 80 deg., with the result that the corn was saved and delivery thereof effected.

A process for spraying metals upon any kind of surface, using metal melted in an electric arc and blown by means of gas jets upon the surface to be covered was described in a German publication. The metal to be sprayed forms one of the electrodes of the arc, and the gas jets are directed so as to strike the sides of the metal electrodes without impinging on the arc and blowing it out. If the arc is produced between two electrodes, one being metallic, and a stream of non-oxidizable gas is directed onto the electrode, portions of the electrode that are melted will be carried away in the form of a fine spray, and may be deposited on any surface on which they impinge, thus forming a metallic skin on it. Suitable control apparatus is provided to allow for the wear of the electrodes.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 6.

1,274,383. APPARATUS FOR UNLOADING COMPRESSORS. William H. Callan, Franklin, Pa.

1,274,396. DYEING-MACHINE. Howard M. Dudley, Philadelphia, Pa.

1,274,418. HUMIDIFIER FOR GASOLENE-ENGINES. Paul Hunt, Brookline, Mass.

1,274,478. AIR-GENERATOR. Frank I. Webb, McKeesport, Pa.

1,274,752. COMBINATION JOLT-RAMMING AND STRIPPING MACHINE. William C. Norcross, Terre Haute, Ind.

1,274,766. PNEUMATIC PIANO-PLAYER. Claus E. Peterson, Worcester, Mass.

1,274,810. VACUUM FUEL-FEEDING SYSTEM FOR GASOLENE-ENGINES. Harold C. Suckert, New York, N. Y.

1,274,955. FLUID MOTOR OR PUMP. August Sundh, Hastings-upon-Hudson, N. Y.

1,274,970. METHOD OF PRODUCING AND SEPARATING LIQUEFIED GAS. Linus Wolf, Chicago, Ill.

1,275,030. AIR-MOTOR. Olaf L. Howe, Missoula, Mont.

1,275,033. PNEUMATIC-TIRE VALVE. William C. Huntoon, Providence, R. I.

1,275,108. TRIPLE SANDING APPARATUS. Harry Vissering, Chicago, Ill.

A locomotive track sanding apparatus comprising in combination a sand trap, a rear sander and a plurality of front sanders on one side of a locomotive and fluid pressure means for discharging sand through either the rear sander or a plurality of front sanders.

1,275,171. TOOL-ACTUATING DEVICE. Thomas Officer and Morris P. Holmes, Claremont, N. H.

1,275,180. FLUID-PRESSURE GAGE. Evenio Ellis, Sheffield, England.

AUGUST 13

1,275,282. PRESSURE-GAGE FOR AIR-PUMPS. Raymond C. McGrath, Okemah, Okla.

1,275,306. PNEUMATIC SUPPORT FOR STRETCHERS AND BEDS. Morris W. Rosenshine, San Francisco, Cal.

1,275,316. PNEUMATIC CLUTCH. John Springer, Batavia, N. Y.

1,275,121. FEEDING GLASS. Halbert K. Hitchcock, Tarentum, Pa.

The method of feeding molten glass to shaping mechanism, which consists in drawing by suction a pre-determined quantity of the glass from a receptacle containing molten glass into a stationary inclosed displacement chamber, applying fluid pressure to the glass in the displacement chamber and thereby discharging it to the shaping mechanism and substantially emptying the displacement chamber, and then repeating the operation.
the operation.

1,275,410. AIR-PUMP. Harry O. Johnson, Calhan, Colo.

1,275,479. SAFETY-VALVE FOR AIR-

BRAKES. Michael H. Ryan, San Bernardino, Cal.

1,275,536. PROTECTIVE DEVICE FOR MOTOR-COMPRESSORS. Philip L. Crittenden, Edgewood, Pa.

1,275,547. APPARATUS FOR DRYING FRUIT. Thomas W. W. Forrest, Oakland, Cal.

1,275,592. AIR-LIFT BOOSTER. John Oliphant, Chicago, Ill.

1,275,747. AUTOMATIC VACUUM-CLEANER. George V. Rasmussen, New York, N. Y.

1,275,843. UNLOADING MECHANISM FOR COMPRESSORS. William H. Callan, Franklin, Pa.

AUGUST 20

1,276,016. AIR-CLEANER. Ashley C. Bennett, Minneapolis, Minn.

1,276,036. AIR-BRAKE FOR RAILROAD-TRAINS. Merrit A. Culling, Louisiana, Mo.

1,276,048-9. AIR-BRAKE FOR RAILROAD-TRAINS. Ernest D. Finley, Louisiana, Mo.

1,276,126. TIRE-PUMPING MECHANISM. Jacob L. Shroyer, Pittsfield, Mass.

1,276,163. CONTINUOUS-VACUUM DEHYDRATOR. Charles Biesel, El Paso, Tex.

1,276,184. MILKING MACHINERY. Norman John Daysh, Poughkeepsie, N. Y.

1,276,251-2. MACHINE FOR TAPPING BLAST-FURNACES. Benjamin J. Mullen, Leetonia, Ohio.

1,276,310. PNEUMATIC VEHICLE-SPRING. Henry P. Arndt, Amston, Conn.

1,276,373. METHOD OF AND APPARATUS FOR PUMPING FLUIDS. David W. Jones, Los Angeles, Cal.

1,276,478. FLAP-VALVE FOR TWO-CYLINDER COMPRESSORS. Reuben E. Bechtold, Fort Wayne, Ind.

1,276,495. SUCTION APPARATUS. John T. Crockett, Cartersville, Ky.

1,276,505. AIR-LIFT PUMP. Levi T. Edwards, Philadelphia, Pa.

1. In an air lift pump, an eduction pipe having the bounding wall of its bore formed of wood, said wall being uniformly tapered to provide a bore gradually increasing in cross-sectional area from the inlet end to the outlet end of said pipe.

1,276,506. AIR-LIFT PUMP. Levi T. Edwards, Penfield, Pa.

A foot piece for an air lift pump consisting of an annular body, a plurality of ring nozzles of different diameters, and means to support said nozzles in axial alinement with said body.

1,276,683. METHOD OF DRILLING GLASS. Harry Northwood, Wheeling, W. Va.

The method of drilling glass which consists in simultaneously subjecting opposite sides of a thickness of glass to the action of blasts of sand which meet and complete the cutting operation at a point intermediate the opposite faces of the thickness of glass.

1,276,699. PNEUMATIC-DESPATCH DELIVERY TERMINAL. Albert W. Pearsall, Lowell, Mass.

AUGUST 27

1,276,762. AUTOMATIC AIR-SUPPLY DEVICE AND COMBINATION-GOVERNOR THEREFOR. Edward G. Hodges, Marshalltown, Iowa.

1,276,803. MILKING-MACHINE. Carl H. Paarmann, Delmar, Iowa.

1,276,836. AIR-FEEDING DEVICE FOR FORGES, FURNACES, AND THE LIKE. Burton H. Tripp, Philadelphia, Pa., and Hugh V. Ramsay, Gloucester City, N. J.

1,276,871. VACUUM WATER-PURIFICATION SYSTEM. Oliver M. Campbell, Kansas City, Kans.

The process of purifying water which consists in distilling the water and removing the gaseous impurities from the vapor during condensation by subjecting said vapor to a continuous vacuum action at various points corresponding to the various successive stages of condensation of said vapor.

1,276,939. OIL-BURNER. William Mallory, Topeka, Kans.

In an apparatus for the purpose set forth, the combination of an oil reservoir, a compressed air reservoir, means for establishing a flow of air from the compressed air reservoir into the oil reservoir, a coil connected with the oil reservoir, means for controlling the flow of oil into the coil, means for admitting air to the upper end of the coil, a burner carried by and communicating with the lower end of the coil, means for admitting air to the lower end of the coil, and means for controlling the flow of fuel from the coil to the burner.

1,276,976. ATTACHMENT FOR AIR-BRAKES. Fred T. Shaw and Joseph G. Meador, Jr., Winchester, Miss.

1,276,987. APPARATUS FOR PRESERVING OBJECTS CONTAINING FLUID UNDER PRESSURE. Frank W. Stockton, Chicago, Ill.

1,276,989. AIR-GUN. Sven Svenson, La Crosse, Wis.

1,276,998. FLUID-PRESSURE BRAKE APPARATUS. Walter V. Turner, Wilkinsburg, Pa.

1,277,001. LOCOMOTIVE BRAKE DEVICE. Walter V. Turner, Wilkinsburg, Pa.

1,277,053. AIR-BRAKE MECHANISM. Samuel H. Elliott, Roanoke, Va.

1,277,068. WELDING-TORCH. John Harris, Cleveland, Ohio.

1,277,069. VALVE MECHANISM FOR BLOW-PIPES AND THE LIKE BURNERS. John Harris, Cleveland, Ohio.

1,277,080. RIVETING-HAMMER. Francis E. Johnson, Altoona, Pa.

1,277,143. AIR-BRAKE. James G. Smeltzer, Germantown, Pa.

1,277,151. CONDENSATE AND AIR REMOVING APPARATUS. Robert Suczek, Philadelphia, Pa.

1,277,261. AUTOMATIC AIR-BRAKE SYSTEM AND TRAIN-STOP. Frank A. Russ, Weatherly, Pa.

1,277,269. SPRAYING OR ATOMIZING SYSTEM. Herman Edward Sturcke, Brooklyn, N. Y.

Method of atomizing or spraying material such as paint by means of carbon dioxid in a pressure container, consisting in leading a stream of high pressure carbon dioxid gas from said container through a heated liquid bath, thereby heating said gas, reducing the pressure of said heated gas, leading said gas at reduced pressure through a heated liquid bath whereby to re-heat said gas, and subjecting the material to be sprayed to the action of said gas.

1,277,314. PRESSURE-GENERATOR. Frederick Homewood, Syracuse, N. Y.

1,277,320. OIL-BURNER. William A. Kinney and John F. Straitz, Philadelphia, Pa.

SEPTEMBER 3.

1,277,383. APPARATUS FOR PUMPING LIQUID AND GAS. Louis Bond Cherry, Kansas City, Mo.

1,277,393. APPARATUS FOR TREATING AIR AND THE LIKE. Alfred E. Davidson, Newark, N. J.

1,277,420. FLUID-COMPRESSOR. Samuel H. Human, Chicago, Ill.

1,277,529. PNEUMATIC ORGAN-ACTION. Basil G. Austin, Hartford, Conn.

1,277,586. AIR-MOISTENING DEVICE. James P. High, Fairview, Okla.

1,277,632. HUMIDIFIER. George Mizener, Decorah, Iowa.

1,277,684-5-6. VACUUM FUEL-FEED DEVICE. Louis Berg, Chicago, Ill.

1,277,752. AIR-COMPRESSOR. William Reavell, Ipswich, England.

1,277,779. COMBINATION GAS-ENGINE-DRIVEN AIR-COMPRESSOR. Frank M. Titus, Bradford, Pa.

1,277,831. ARMORED PNEUMATIC TIRE. Walter E. Baumberger, Sacramento, Cal.

1,277,854. TRAIN CONTROL. Howard Carlisle, Leesburg, N. J.

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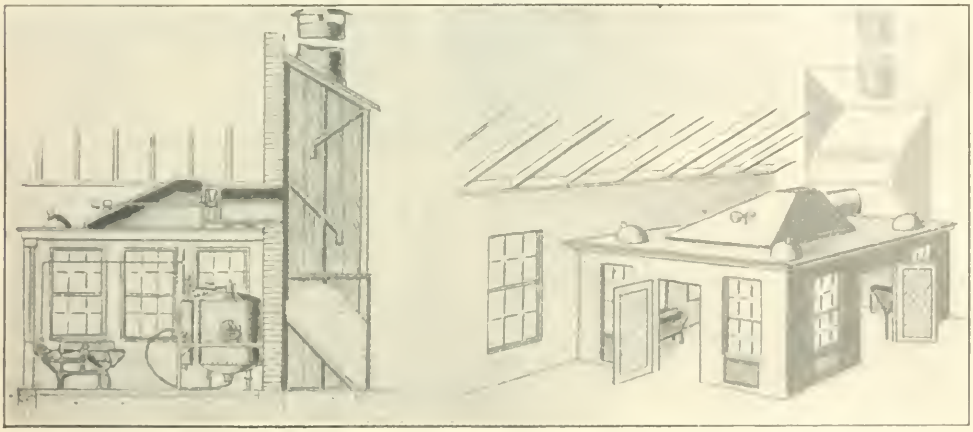

FIG. I. STANDARD SAND BLAST INSTALLATION

SELECTING SAND BLAST EQUIPMENT*

By H. D. Gates

Any discussion of sand blast equipment must recognize that probably no other class of men are as familiar with its operation as the foundrymen, for it was in the foundry that the sand blast found its first broad and general application.

Every foundry has conditions and operations peculiar to itself. Each installation should be an entirely individual problem; but it is far from such when the foundryman writes for "catalog, prices and delivery."

One of the largest establishments in its line in the United States, producing war material, sent out over the signature of its purchasing agent a so-called specification for a sand blast installation, asking "prices and delivery by return mail." The specification as written showed such lack of adaptation to the stated requirements that an engineer was immediately sent to ascertain existing conditions. Let us quote the engineer's report:

"I shall never forget Mr. Purchasing Agent. We seriously wounded his pride by hinting that his letter was not entirely sufficient to give an intelligent bid on his requirements. His response to my introductory remarks was: We are extremely busy here and perhaps your time also is limited. You have wasted valuable time in calling here that could have been used preparing data that would have been of service to us. Good bye!'"

A proposal, nevertheless, was made on this so-called specification, and it figured in the

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*From a paper before the American Foundrymen's Association.

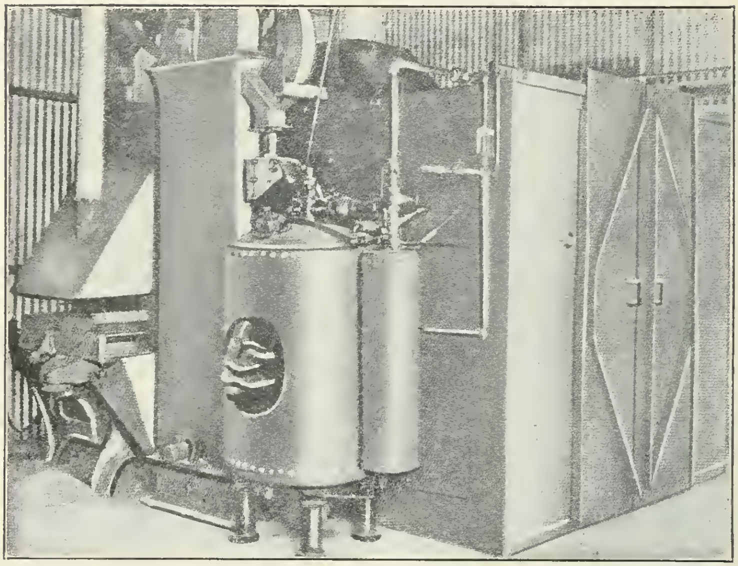

FIG. 2. STEEL PLATE ROOM WITH PRESSURE MACHINE

neighborhood of $20,000. Later another department asked for an engineer to call and go over the plans. A four-hour conference developed conditions that entirely eliminated the original specification and led to the substitution of a plan suggested by the sand blast engineer, with a saving of over $6,000 on the initial cost.

Obviously in the installation of sand-blast equipment the foundryman must turn to the manufacturer. The manufacturer's qualifications to give the service desired must include: Long and varied practical experience; an organization for the design, manufacture and installation of sand-blast equipment; physical and financial facilities for production; and a line so complete as to permit of unbiased counsel in suggesting equipment. A representative should visit the plant and make observations of conditions and operation. Men of the foundry organization who will be the deciding factors, should discuss the subject fully and thoroughly until their minds are met on what is needed. With plans and suggestions prepared the foundryman should go over them again with the sand-blast engineer until entirely conversant with the plan, the operation of the installation and the results to be obtained. Two or three conferences along these lines will save time, give a more intelligent understanding than is possible by proxy or corresponding and secure an investment that will pay a constant return. Keep the problem away from the purchasing end, for by training they can't see beyond the invoice figures, and money is not made there. Measure the price of the sand blast installation by the cleaning cost per ton.

Basically sand blast machines will divide into four general groups as follows: Hose machines; cabinets; barrels; and tables. The method of operation may be either the direct pressure, the suction (syphon) or the gravity systems.

DIRECT PRESSURE SYSTEM

In direct pressure systems the sand is under pressure in a sealed container, sand and air being discharged in combination without expansion through a hose nozzle giving the greatest velocity and highest efficiency possible. The majority of hose machines are of the direct pressure type, indeed, the first ap-

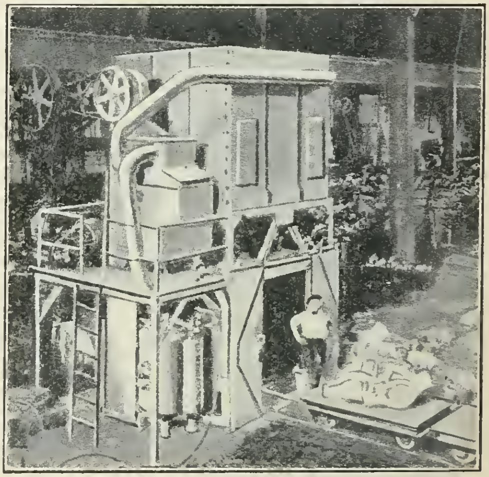

FIG. 3. SAND SEPARATING AND ELEVATING

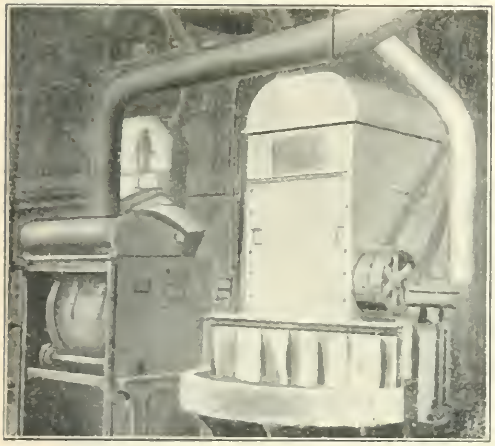

FIG. 4. ROOM AND BARREL

plication of sand-blasting was the hose machine type and it is still used without exception in sand-blast room installations. It offers a range of application that is possible with no other type. For a line and character of work that is varied and of medium volume it undoubtedly represents the most satisfactory equipment. Where the tonnage is large and the pieces are of a weight and size too great for convenient handling it is indispensable. The use of the hose machine demands some enclosure and experience has shown the wisdom and economy of a well ventilated and well lighted room for the purpose.

SAND-BLAST ROOMS

While the cleaning cost will always be reduced by mechanical methods of handling the work and the abrasive for reuse, a convenient room can be provided with small outlay and may be built of rough lumber as shown in Fig. 1, with an exhaust fan in the ceiling or wall, carrying the dust-laden air into a settling box or chamber that will retain the heavier particles. The lighter material is carried off into the atmosphere.

The inclusion of mechanical handling and screening of the abrasive makes a steel room most advantageous and economical. The simplest of these provides for the location of the sand-blast outside the room which is left free for the blasting operation, with controls extending inside to within easy reach of the operator, as illustrated in Fig. 2. A mechanical separtor, driven by a powerful air motor, removes both fine and coarse material at one operation. The clean, sharp abrasive for reuse is delivered by an elevator to a sand storage bin above the sand blast machine for refilling. In this type of room the speed abrasive is shoveled from the floor to a chute in the side of the room connected with the separator.

EXHAUSTING DUSTY AIR

Some diversity of opinion is expressed as to the most satisfactory system for removing the dust laden air. Theoretically it is desirable to keep the dust in transit below the operator's head, and this theory creates some adherents for the downdraft system whereby the dust laden air is drawn downward through the grated floor. Failure in practice to keep the gratings clear, however, seriously retards circulation and experience has demonstrated that more positive results are obtained from an updraft, where there can be no interruption to the draft, and generally better operating conditions are secured.

In considering claims for conditions provided within sand-blast rooms common sense tells us the dust is there, and no improvement is possible over its removal as fast as produced. Not only is this rapidity of removal essential from the standpoint of hygiene and sanitation, but equally so to provide clear vision for efficiency in cleaning. Obviously protection for the operator from the dust-laden air and the flying abrasive other than afforded by the exhaust system must be provided. The most satisfactory device is a dust-proof ventilated helmet. Air is introduced into the helmet from the compressed air line, to which the helmet is connected by a small flexible hose, weighted over pulleys to take up slack in any position and permit ease of movement to the operator.

ROOM EQUIBMENT

Some foundries having sufficient tonnage of both large and medium work have obtained a reduced cleaning cost by installing a battery of two or more rooms, equipping each as the proportions of the work demand with car or table, as shown in Fig. 6.

The rotative tables are up to 90 inches in diameter and have a high partition across the center that completely closes the aperture in the room structure. The material to be cleaned is loaded onto the exposed half of the table, outside the room, by common labor;

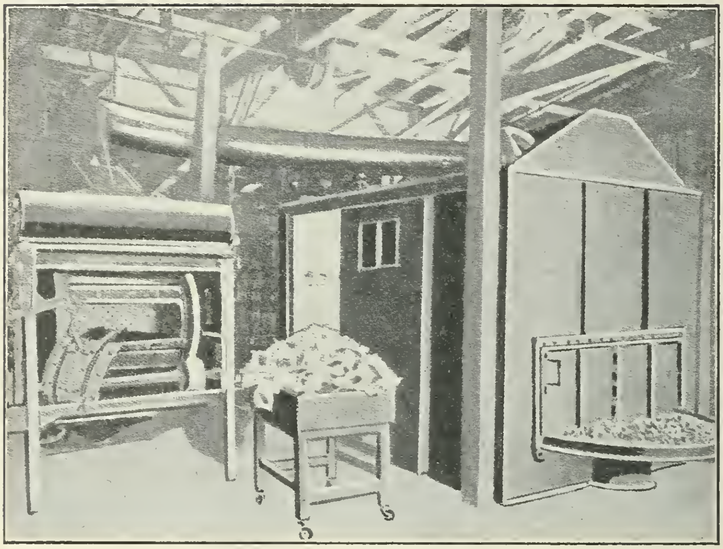

FIG. 5. AUTOMATIC REVOLVING TABLE MACHINE

the table travels on ball bearings and is turned by the sand-blast operator to expose the cleaned work for unloading and to bring new work into the room for cleaning.

The entire time of the sand-blast operator should be devoted to the cleaning operation only. The handling of the work to and from the room should be done by other help. Frequently two operators are worked in a shift. While one is sand-blasting the other is delivering cleaned work and bringing up the new material for cleaning. Each thus handles and cleans his own work, which, in addition to giving continuous operation of the sand-blast, provides a periodical change of occupation.

Where the work is of a character requiring room cleaning and still all within the range of sizes to admit of cleaning on the rotative table; the hygienic table cabinet, Fig. 7, offers advantages. A semicircular cone-top steel cabinet fits closely to half the circumference of the table, the upright partition across the center of the table entirely closing the rear of the cabinet leaving half the table exposed. In the front of the upright wall of the cabinet and extending the entire length is an opening covered by a flexible sectional rubber curtain that retains the abrasive within the enclosure and through which the hose nozzle from a direct pressure blast is directed onto the work to be cleaned. Unobstructed view of the work and interior is provided through a screen covered opening in the cone. Electric light fixtures provide satisfactory illumination.

CABINET AND BLAST

The cabinet sand-blast, a self-contained unit ready for instant use when attached to the air line, is essentially an auxiliary in foundry sand-blasting. The blasting operation is of the suction or syphon type. The abrasive is brought to the nozzle by a partial vacuum created by a jet of compressed air. The air and abrasive are discharged in combination through the sand nozzle, which, being of greater diameter than the air jet, admits of expansion with correspondingly decreased velocity, so that while the blasting efficiency with equal gage pressures is below that of the direct-pressure type, it is a most satisfactory device for special or precision work not economically handled by a large installation. The floor of the cabinet being perforated, the spent abrasive flows back to the feed box, giving a continuously operating machine.

SAND-BLAST TUMBLING BARRELS

For small work in any considerable amount, and particularly where no detriment to the pieces would result from the slow rolling process, no device shows the speed and economy of the barrel sand-blast. While the first adaptation of this system, consisting of placing the nozzle of the hose sand-blast in the ends of a revolving barrel, is still seen in some types, refinements have brought the barrel sand-blast a secure position of its own.

For small brass and malleable work that has been cleaned before annealing, the suction type will be found entirely efficient and has the advantage of a single self-contained unit with low first cost. Three or four nozzles, according to size, cover the entire length of the drum and in the highest developed types the nozzles are adjustable as to direction of different characters of work. This construction, too,

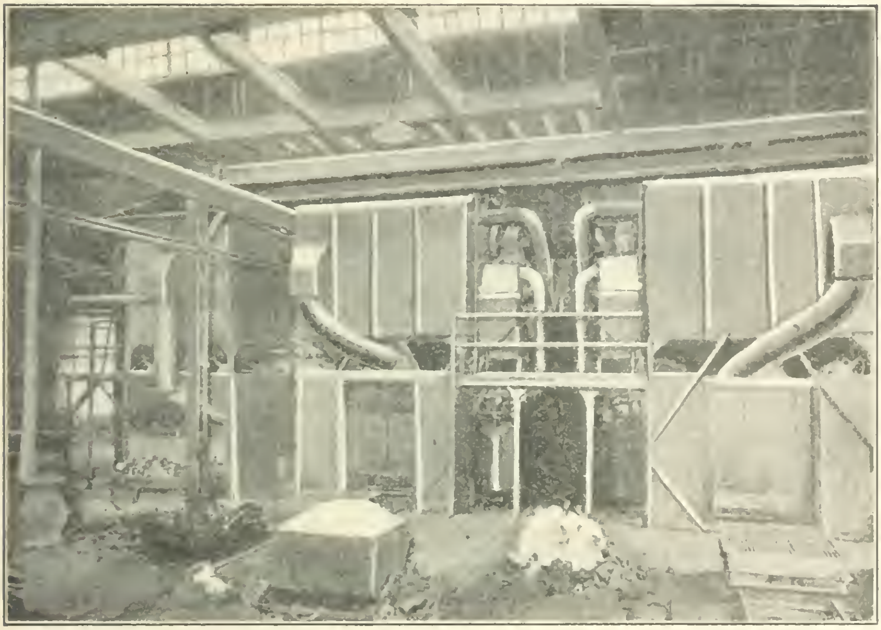

FIG. 6. ROOM WITH TABLE AND CARS

permits the elimination of projecting nozzles that may catch and damage the work or the machine, as well as offering an inswinging door that allows removal of the load by dumping without raking or other handling.

Large castings of either brass, iron or steel demands a heavier design, and the combination of such a barrel with a room installation will take care of a considerable output of varied work. The blasting action is of the gravity type, the abrasive being delivered to the nozzles by mechanical action and gravity; in portion of the force of the air is expended in raising the abrasive, and as the ratio of the air jet to the sand nozzle is greater than in the suction system, less expansion of the air takes place with proportionately increased blasting efficiency. The nozzles are located in each end of the drum, leaving the interior entirely unobstructed so that the size of pieces that can be cleaned is limited only by the dimensions of the door opening. The abrasive passes through perforations in the drum and falls into a hopper that conveys it to the elevator boot. As it is delivered from the elevator, a strong exhaust removes the fine light material, and vibrating screens reject everything that will not readily pass the nozzle, giving a continuous flow of evenly graded, clean, sharp abrasive. For the foundry whose product is of a size and character that will admit entirely of barrel cleaning, there is no one other device that is as economical and satisfactory.

AUTOMATIC REVOLVING TABLE TYPE

There are classes of work that by reason of shape do not adapt them to barrel cleaning. This includes precision work or pieces that are so light and fragile as to not admit of this method of sand-blasting, and are yet too small for individual cleaning to advantage with the hose machine in room installation. For this character of output the automatic revolving table sand-blast, Fig. 7, has found high favor. A grated-top table half exposed and half housed revolves at a slow speed. Within the housed portion a series of nozzles, fed from a direct high pressure hose blast, are oscillated in adjustment with the varying peripheral speeds of the table, so that all points are brought with equal duration within the path of the blast stream. The pieces to be cleaned are placed on the exposed portion of the table as it revolves; they are turned as required and removed when cleaned. A flexible sectional rubber curtain permits passage of the pieces to and from the housing while retaining the abrasive within the enclosure and protecting the operator from dust and flying particles.

ABRASIVE MATERIALS

The metal abrasives have many times the life of sand, do not require large storage capacity and create less dust in use. Their comparatively high initial cost demands careful reclaiming methods, as any considerable daily loss soon wipes out the saving their long life affords. To some lines of work they do not successfully lend themselves without after-cleaning of the pieces, as the fine metallic dust adhering by force of the blast creates defects in galvanizing, plating, etc. Moisture in the air lines, too, is a decided deterrent to the use of metal abrasions, due not only to the fact that they do not flow freely when damp, but may readily rust into a solid mass.

Of the various sands offered silica and ocean sands only have the sharpness and hardness to make a satisfactory sand-blast abrasive. At the same, or even an advanced cost, undoubtedly the silica sands would have a general preference. Owing to the restricted areas of production, however, freight rates operate against their use at any considerable distance from the source of supply. It is only by a trial of each that an intelligent selection of available sands can be made, and some initial expense in comparative tests of all the various sands and metal abrasives will undoubtedly be fully returned in satisfactory results and economy of sand-blast operation. Highest blasting efficiency from any abrasive, however, may only be anticipated when it is evenly graded, dry and free from loam and dust.

TROUBLES IN PRACTICE

Operating troubles may usually be traced to three general causes, air pressure, moisture and abrasive. An installation that fails to provide for adequate control and regulation of these can hardly be called complete or expected to give maximum results.

All other factors being normal, air pressure governs results. When it is remembered that results at 20 pounds pressure are but half that at 56 pounds; at 30 pounds half that at 64 pounds, and at 40 pounds half that at 72 pounds, it is seen that the increase in output and saving in labor will demand the maximum pressure that the character of the work will permit. Obviously soft brass will not stand the pressure required for cleaning steel, nor will the molding sand fuse and burn to the casting in a degree to demand such high pressure.

Air volume should be ample and the flow steady. Air means horse-power, which in turn costs money, and the air volume should be restricted to the minimum to obtain the required results. As the flow of air increases four-fold with increases in the diameter of the nozzle, restriction at this point is most essential. It means not only a constant saving in operating cost, but in the case of limited air supply, increased air flow may cause a drop in pressure with a corresponding reduction of output.

This feature cannot have too careful attention. For example, a new nozzle with ¼-inch diameter opening, *A* and *B*, flows, at 80 pounds pressure, 85 cubic feet of free air per minute. If the nozzle enlarges with use, *D*, an increase of 1/64-inch increases the air flow by 12.5 per cent. With a 1/32-inch increase in diameter the air flow increase is 27 per cent. and by a 1/16-inch increase in diameter the air flow has increased 56.5 per cent. The nozzle should retain the original inlet size as it wears at the discharge end. Not only economy dictates this but it permits of predetermined air and horsepower requirements.

It is rather past conception that anyone would permit water to get into the gasoline tank of his automobile. The results would be disastrous, but how many are making provision to eliminate the water from their compressed air lines? In many cases, the air passes the "moisture" stage, and trouble is immediately experienced.

Moisture is detrimental to all air-operated tools and as it is variable with weather conditions some provision for its elimination before delivery to the sand-blast or to other tools is the truest economy. Various devices are produced for this purpose and where the moisture volume is not abnormal a simple separator, consisting of a vertical tank fitted with a series of solid and perforated plates in pairs placed at a slight angle from the horizontal is effective. The air supply pipe is carried to the bottom and is copped at the end, the air being discharged through small holes aggregating the area of the pipe suction. From the bottom of the tank the air passes through the openings in the perforated plates striking the

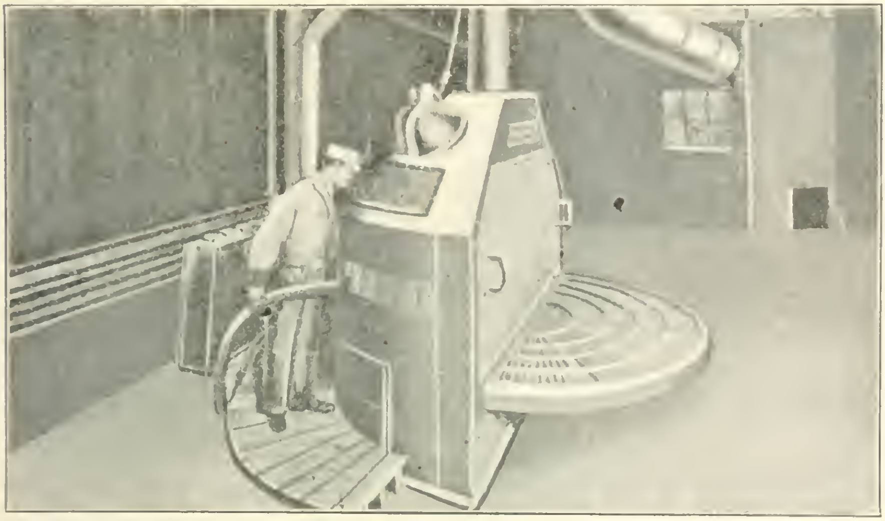

FIG. 7. HYGIENIC TABLE CABINET

solid plates immediately above each and passing around the outside to the next series, this operation being repeated several times until finally it reaches the top of the separator and flows through the outlet to the sand-blast machine.

The principle involved lies in the fact that when air at high pressure and velocity is compelled to take an abrupt change of direction, the heavier particles of air, containing the moisture, by their momentum will strike the walls of the apparatus in which the change of direction takes place. This causes compression of the particles of air which tends to separate out the moisture and deposit it against the walls of the vessel.

Where the moisture is excessive, even if only at certain seasons, an aftercooler or a reheater is a necessity. While the aftercooler is most effective, some plants have found satisfactory relief in the reheater, although its function is not at all that of eliminating any of the moisture.

Each function in the operation of a sandblast is to an extent dependent on the perfect operation of the others. Therefore maximum results cannot be anticipated from the poor or powdered abrasive even with dry air at high pressure. Both sand and the metal abrasives show some disintegration with use and the fine dust together with core and molding sand and all fine material must be removed constantly from the abrasive. This material has no abrasive ability, but it consumes air just the same.

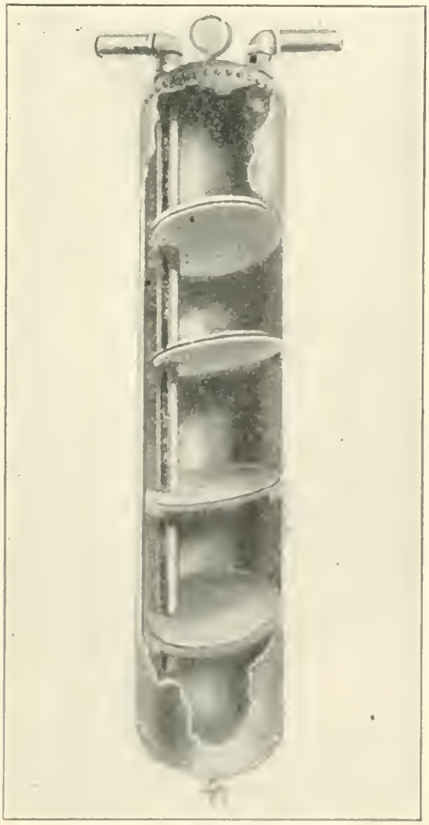

FIG. 8. MOISTURE SEPARATOR

Clean, sharp, dry abrasive graded to the requirements of the work will increase the output amazingly. A thorough understanding and application of basic principles will save time, worry and expense. The help of a competent service man will often more than repay the expense entailed particularly if some one in authority in the foundry organization will cooperate.

VARIOUS SALVAGE FEATS*

By Robert G. Skerrett

Within the last few months the United States has become represented in the Joint Salvage Council of the Allies. Besides sending to Europe some of the best of our civilian and naval salvage experts, we have equipped and dispatched a number of vessels uniquely fitted for the speedy and effective handling of damaged or sunken ships.

The first work of our experts sent to the other side was to study conditions and to devise ways in which we could act to best advantage. The salvage steamers since prepared for the service embody everything thought essential to effective operations, and reflect the judgment of men whose brilliant achievements in a peculiarly difficult branch of engineering have placed us in the very forefront of the art.

Our salvage corps in Europe, however, is not succoring or refloating American ships only, as was originally intended. We have pooled our skill and equipment with those of our allies and are now actively coöperating with the Salvage Department of the British Admiralty. And that we may have an idea of the capacity of the men we have sent abroad, just let us review briefly some of the amazing things they have done in American waters in the past few years. They tell better than anything else just what Yankee resourcefulness really means—a resourcefulness that does not hesitate to put tried agencies at work in untried fields and by means of sheer audacity to accomplish the seemingly impossible.

THE ROYAL GEORGE

To begin with, there was the S. S. Royal George, a big liner of fifteen thousand tons, which ran high upon the rocks in the St. Lawrence—that graveyard of ships—while racing seaward during a heavy fog. Substantially forty per cent. of her underwater plating was damaged and great rents torn in her steel skin, through which the river ebbed and flowed freely.

The vessel had in her at the time of her grounding only a moderate amount of cargo, and there was, therefore, comparatively little that could be taken out of her to lighten her. This was done, but it failed to break the grip of the bowlders that had pierced her bottom; and it was found impossible to drag her off bodily, despite the efforts of a flotilla of powerful tugs, augmented by a number of larger steamers. To make things worse, the rise and fall of the tide was a matter of sixteen feet, and the Royal George struck at high tide.

A New York salvage expert was summoned to Quebec and, undismayed by the problem, promised to get the ship off; and he did so. He sealed the decks and hatches above the injured holds, fitted air locks to the hatch covers, and then went ahead as if his job were one of subaqueous tunneling. He turned compressed air into the flooded compartments, and in an astonishingly brief span of minutes forced the invading water down and outward through the rock-torn gaps until the water was level with the top edge of the uppermost injury. Then he sent his gangs of sand hogs down through the air locks into the holds.

These men, who had also learned their trade in driving tunnels under rivers, laid planks over the wounds, starting at the top of each, and filled the crevices with clay. The compressed air helped to hold these "pudge" boards in place and at the same time drove the water down and out as the rents were gradually covered. In this way the Royal George was given sufficient buoyancy to raise her clear of the river bed and permit her to be towed into deep water; but this was only half the task.

Winter was near at hand and with it the likelihood of the St. Lawrence's freezing before the liner could be taken to the nearest dry dock and made fit for sea. A great deal of money was at stake, and her owners wanted to get her back to England so that she could be overhauled and made ready for service. The situation was met in a thoroughly orig-

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*Abstracted and condensed from *The Saturday Evening Post,* Oct 26, 1918.

inal manner the steamship was repaired just where she floated.

THE SAND HOGS

The sand hogs made patterns of the patch plates needed to seal each wound in the hull. These patterns showed, also, just where threaded bolts were to be screwed into the patch plates, and these marks corresponded exactly with others placed around the injuries, where holes were drilled through the sound steel of the hull and temporarily plugged with wooden stoppers from within.

As each patch plate of steel was made ready it was lowered over the side and brought into position by divers standing upon a submerged and weighted platform. At the right moment the wooden stoppers were pulled out and the bolts on the patch plate shoved inward. Working quickly, the sand hogs fitted the nuts on the bolts and screwed them tight. The repairs thus made were found, when the ship was docked for inspection, to be so sound that nothing more was done on her at the time, and the Royal George ran to England with a profitable cargo.

THE URANIUM

Again, the steamship Uranium, bound for New York via. Halifax, stranded upon the rocks just outside that Nova Scotia port. She was refloated after five days of work and towed into Halifax; but the only suitable dry dock was occupied. Her bow and forward bottom were so seriously damaged that it was quite impossible for her to put to sea in that condition.

Compressed air, resorted to by an American salvage expert, saved the day. The wounds were covered from within with sheets of flexible lead so bent that they fitted snugly over the rents. Upon the lead sheeting was laid a mattress of cement. When the injured compartments were charged with compressed air the patches were held securely. The craft reached New York after a two days' run, carrying a valuable cargo.

THE ZEELAND

There was the case of the steamship Zeeland, driven far up on the flats of the St. Lawrence in a fog. The mud was dredged from both sides of her and a path was dug sternward back to the channel, and the ship was lightened by discharging, coal, water ballast and portable equipment, but powerful tugs and other craft were unable to pull her from her bed of mud.

AIR BUBBLES DID IT

The man who salved the Royal George released the Zeeland. He did it by means of a film of air bubbles discharged from holes drilled in the bottom of the liner. The air passing outward and upward broke the suction grip of the mud, freed the ship and she was then towed back into the river fairway.

THE GUT HEIL

Every salvage case is different from every other. There was the big tanker Gut Heil, sunk in the Mississippi, which was raised by compressed air after lying abandoned for five years. She had turned over on her side and was filled with hundreds of tons of mud, and the problem was to turn the ship upright in shallow and nontidal water and then to refloat her.

Compressed air did the trick. Buoyancy so obtained and carefully distributed righted the ship after she had been freed of the bulk of the mud inside. The task involved the nicest sort of juggling with water ballast and buoyant air so that the ship would come slowly upright and then not lurch over on the other side. The feat as a whole was without a parallel in marine wrecking.

THE DIVERS

These are the most important and responsible workers in wrecking operations. The operating zone has been greatly extended so that operations are carried on at greater depths and the worker is no longer hindered by the air hose. Compressed air is now drawn from storage flasks so that with an ample and unfailing flow of this vital element assured it is now possible for the diver to control his air supply to a nicety and to meet confidently the changing requirements. It has also been found to be practical and safe to reduce considerably the length of time a diver must remain in the water when coming up from a deep descent in order to bring about a readjustment of physical conditions. By the prompt use of the recompression chamber, one of which is on each of our salvage boats, the development of "bends" can be prevented and the aftermath of still graver bodily reactions effectually offset.

THE BRITISH WORKERS

With our men collaborating with the English and French experts there is good reason to believe that 1918 will prove a bumper year miralty's Salvage Section was devoted to taker's U boats. One of our own sailors has paid this spontaneous tribute to his English professional brethren:

THE CELTIC

"For sheer grit and dogged persistence, I take off my hat to the British wreckers. I first saw them in action when they made port with the torpedoed Celtic last April. She was hard hit. Her great bulk of twenty-one thousand tons was made heavier and more difficult to handle by reason of the water that had poured into her through her gaping side. The Irish Sea at that particular time was in an ugly mood, thanks to a nasty wind; and, believe me, it was a man-sized job to get hold of that ship and to tow her into a haven, all the while battling with the threatening sea to keep the craft from filling up and going to the bottom.

"The Celtic was potted somewhere in the neighborhood of the entrance to St. George's Channel, where a number of other big ocean-going vessels had fallen prey to lurking U boats. Within an amazingly brief while after she sent out her S O S calls, a flotilla of salvage vessels and tugs were gathered about her.

"The stricken craft rolled deeply and sluggishly as the waves beat angrily against her massive hull. The salvors' problem was to get alongside of her for the twofold purpose of putting pumps aboard and of securing lines by which she could be towed into harbor. Her fires were out and her own pumps were, therefore, incapable of helping.

"The little salvage vessels stuck valiantly to their job, even though more than one of them was smashed grievously against the liner's steel body. Despite all handicaps, the wreckers toiled undismayed and finally loaded their self-propelled pumps on the sloping and slippery deck of the wounded Celtic. With these powerful pumps the salvors fought on more nearly even terms with the menacing sea, and were able to work the injured liner heavenward and to guide her safely through mine fields to safety."

Up to date the Salvage Department of the British Admiralty has been able to restore to service four hundred and fifty sunken or damaged ships. The British Navy, with its enormous peace-time fleet, was well nigh entirely lacking in salvage facilities until the concluding months of 1914. At the start the Admiralty's Salvage Section was devoted to taking care of stricken battle craft, but by October, 1915, its main function had become that of dealing with damaged or sunken merchantmen.

The man chosen to head the newly formed department of the Admiralty is not a naval officer. He is a practical and very successful marine salvor. Captain Fred W. Young, the man in question, is a bluff, seatanned type of British mariner who scoffs at gold trappings and prefers to work in his shirt sleeves.

SUBMERGED PONTOONS

Ten years ago he wrought a salvage wonder when he turned over H. M. S. Gladiatas, lying on her side in the open waters of the Solent, and refloated that dead weight of six thousand tons notwithstanding the fact that the cruser had a hole in her side fifty feet long which reached from her gunwale down to within a few inches of her bilge keel. He did this by means of submergible pontoons. Since then he has gone on adding to his laurels. No wonder the lords of the Admiralty have given him a free hand.

Captain Young first recruited from civil salvage enterprises a corps of experts and a force of divers familiar with the waters contiguous to the British Isles; and he also requisitioned some of their vessels. The next step was to outfit a goodly number of obsolete gunboats by placing aboard an array of portable pumps, no end of piping, long lengths of chain cables, heavy wire hawsers, massive blocks, diving gear, air compressors, oxyacetylene blowpipes for cutting metal, line-firing guns, wireless apparatus, and a long list of paraphernalia peculiar to the wrecking business.

Quite eighty per cent. of the work of the Admiralty Salvage Department lies in succoring a wounded ship before she can go to the bottom in deep water, as instanced in the case of the Celtic.

THE STANDARD PATCH

A large freighter, laden with a cargo of foodstuffs valued at fifteen million dollars, was torpedoed in the home waters, and went to the bottom in fairly deep water. Her shelter deck, fifty-seven feet above her keel, was just awash for about two hours at low tide. The torpedo that got the ship tore a hole in her side forty feet long and twenty-eight feet wide. Before the war a craft so circumstanced would, in all likelihood, have been declared a total loss; but the Salvage Department looked upon her as a promising problem, and Captain Young's men tackled that job, fortified by special facilities which had been developed or perfected since 1914. Among these are the submergible electric pump and the so-called standard patch.

Pumps were placed deep down in the submerged stokehold of the freighter, and by the aid of divers accustomed to the perilous work of exploring the interior of sunken ships holes were drilled and blasted in divisional walls of steel, so that the water could drain into a common sump, and thence be discharged to the surface. In this way the freighter was lightened so that part of her cargo could be removed and her position shifted to shallower water. There she was temporarily patched, thousands of tons of the goods aboard were unloaded, refloated by further pumping, and then towed to port for permanent repairs.

The so-called standard patch is really an adaptation of the patch plates devised for the repair of the S. S. Royal George. It is doubtful whether our American experts will use it at all, since the patch plate is believed to be easier to make and susceptible of quicker adjustment. The standard patch, however, has proved of undeniable value, and has made it possible to save many a vessel that might still be resting on the sea bed. It is fashioned of planking six inches thick, strengthened by metal strips, and modeled so that it will fit snugly against the outside of a ship and effectually cover the injured area. The form of this patch depends upon the shape of the vessel and the particular part damaged. First, divers are sent down with an adjustable mold of wood prepared after the known contours of the craft in question; and the underwater workers set this against the hull and mark just how the patch must be made to seal the hole. After that, the patch is constructed ashore or possibly on one of the salvage vessels. When ready it is lowered over the side and guided into place by divers working both outside and within the wounded craft; then it is drawn snugly into place by means of hawsers attached to the inner face of the patch and leading into the vessel; finally the timber shield is secured firmly by bolts passing out through the sound shell plating of the hull.

THE O. B. JENNINGS

The American tanker O. B. Jennings, carrying sixteen thousand tons of oil, collided last April in the English Channel with a large freighter, also partly laden with oil and other highly inflammable commodities. The stem of the latter vessel tore a great rent in the tanker's side and the friction caused by the impact set the Jennings aflame. The rescuing tugs found it impossible to subdue the blaze, and to save the splendid ship and her valuable cargo she was deliberately sunk by gunfire. Divers afterward closed the wound occasioned by the collision and plugged the holes made by the shells. The Jennings was raised, towed to port, and temporarily repaired and run to the United States for thorough overhauling. On the fifth of August, unfortunately, the tanker was attacked by a U boat off the coast of Virginia when homeward bound and sent to a watery grave.

The British ship that collided with the Jennings took fire also, and the explosions that followed killed pretty nearly all of her crew. Notwithstanding she was so dangerous as a powder magazine, the wreckers undauntedly approached her to save her. The character of the men in the salvage flotilla was splendidly evidenced by their courage in boarding the flaming freighter in order to attach hawsers so that she might be pulled stern first against the wind for the purpose of preventing the spread of the conflagration within her. After towing the vessel for nine hours a mine exploded under her, parting one of the cables, and a moment later two other mines burst beneath her stern. Finding it impossible to get hold of her again, the craft was sunk by gunfire near an exposed inlet on the south coast of England. The steamer has since been raised.

DANGEROUS GASES

Certain cargoes—such as grains, other vegetable matter, meats, and so on—when exposed to the action of sea water give off poisonous gases, and these have proved extremely troublesome and even fatal where the men were unfamiliar with their noxious character. One of the worst of these has been sulphureted hydrogen, generated by decomposed cereals. The chemists who have done so much toward developing antidotes for the treatment of soldiers gassed on the firing lines have found ways to neutralize the cargo gases, and the simple expedient of spraying the rotting freight with a prescribed mixture has practically disposed of the asphyxiating menace. Some chemicals essential to waging war also react when exposed to water and give off both poisonous and explosive gases, and these can be disposed of successfully only by stimulated ventilation and by taking other precautionary measures.

For instance, one American salvage concern was called upon to refloat a ship sunk in the harbor of St. John, New Brunswick. Among the cargo were a good many tons of calcium carbide, which, when water worked into the containers, gave off acetylene gas and also heated the metal tanks to the point of red-heat. At low tide the whole inside of the ship above water was filled with the gas, and the explosive fumes remained in pockets when other parts of the craft were cleared of it by ventilating blowers. As a very low percentage of acetylene in the air makes an explosive mixture, it was necessary to devise some form of detector. As a result an ingenious and simple gas gun was evolved, and by taking samples of the atmosphere within the steamer it was possible to tell quickly and surely whether danger lurked there for the wreckers. The gas gun will play a helpful part abroad among the craft of our salvage flotilla.

The question naturally arises: What can be done in cases of ships a hundred and more feet down? A submarine, because of the pressure-resisting type of hull and its normal fitness to run under water, lends itself exceptionally well to raising by means of compressed air applied internally so as to provide buoyancy while expelling the invading water. This is not practicable in the ordinary ship, unless she be in a position where it is possible for divers to work inside her, strengthening her decks, sealing hatches, and otherwise bracing her to hold, without rupturing, the expansive or bursting force of the confined buoyant air. Therefore, the main refloating agency will, in most cases of deeply sunken craft, have to be applied externally in the form of a direct lift and through the medium of pontoons.

THE SALVAGE OPPORTUNITY

We have proved practicable, in times of peace, salvage tasks that the British have essayed only under the impelling stress of war. Again, a desperate shortage of sea-going tonnage has brought about wrecking feats that would probably not have been dreamed of commercially because of the great expense involved. However, with substantially unlimited funds now at their disposal, the salvage engineers are taking long chances and doing amazing things. Meantime they are learning much that will cheapen operations in the years to come, when the wreckers will be asked to consider with the cold eye of business the question of refloating or raising hundreds and hundreds of ships which now, for various reasons, cannot be given consideration.

We have gone to Europe to help in a great work and our men can be counted upon to do their part in offsetting the ravages of the Kaiser's U boats. They are likewise over there to profit by the experience of the British, French and Italian salvors. The men who in this fashion are fighting the sinister Teuton sea asps, who are battling with the treacherous, changeful sea, and who are trying to minimize navigational accidents induced by dimmed beacons and blinded running lights, are, indeed, a splendid body. They are facing perils and struggling with difficulties that demand complete self-forgetfulness and unfaltering determination to succeed and, if it be physically and humanly possible. Theirs is a he-man's job; and they are tackling it like red-blooded, two-fisted fighters. They are heroes—all of them.

VENTILATION AFTER MINE EXPLOSION

In the event of the ventilating fan or appliances having been injured, wrecked, or destroyed by the force of an explosion immediate attention should be given to the repairs necessary for reëstablishing the ventilating current. In a drift or slope mine, advantage should be taken of any natural ventilation that has become established. In a shaft mine advantage should be taken of any natural ventilation in exploring on the intake current, especially on ladders and stairways in any shaft through which such natural ventilation is supplying fresh air. Men may be found alive on the stairways. To aid natural ventilation or to establish a current of air in the absence of such ventilation, a spray of water may be directed down one of the shafts to cool the air and cause the shaft to become an intake. On the upcast air compartment a steam jet may be installed to heat the air. The jet should always be placed in the compartment of the shaft in which there are steam pipes, as the heat from the pipes will assist in warming the air and help to make an uptake current.—*Rescue and Recovery Operations in Mines.*

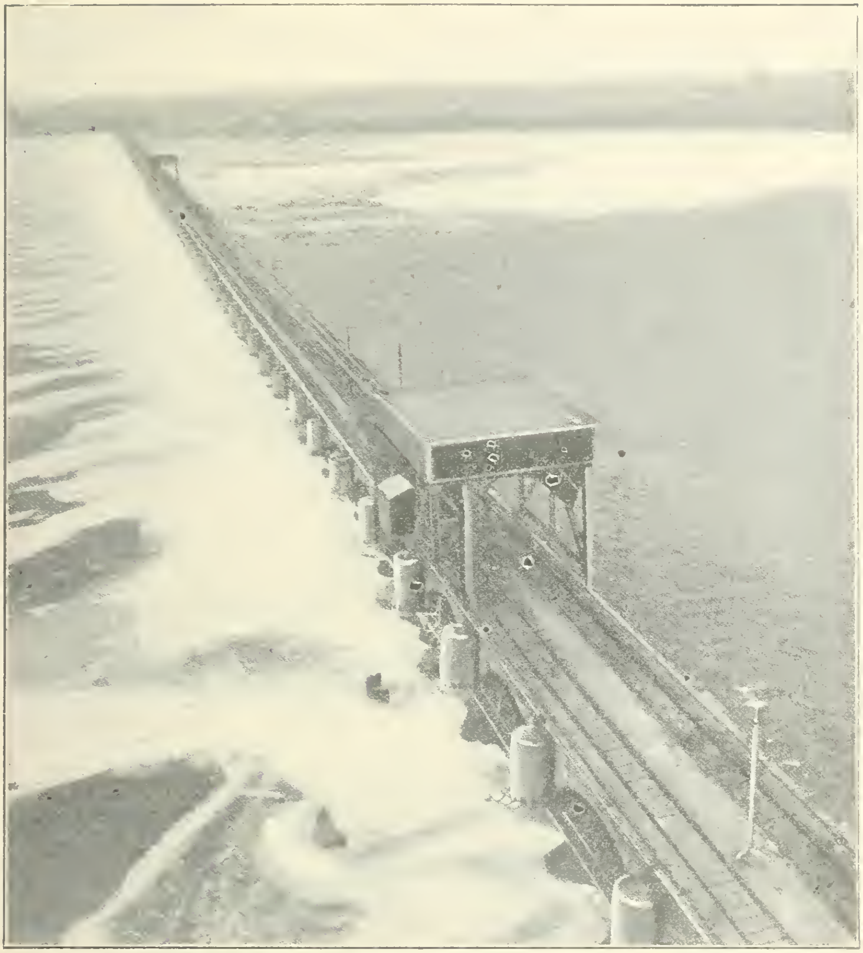


FIG. I. KEOKUK DAM PROTECTED BY COMPRESSED AIR

COMPRESSED AIR CONQUERS ICE THRUST

The following interesting narrative is compiled substantially from an article in the *Stone and Webster Journal*, March, 1918. Being a narrative of winter operations it should be of more suggestive practical value when anticipating the cold season than when supplementing it. The application of compressed air here described was quite unusual and proved far more efficient than could have been predicted.

Heavy ice above the Keohuk Dam on the Mississippi caused serious trouble during the winters of 1915-16 and 1916-17. During the first of these winters heavy floating ice battered and crowded out one of the spillway gates, and in the following winter a steady pressure of thick ice caused permanent deflection of a number of the many gates spanning the spillway openings, which extend all across the river. To prevent the recurrence of such conditions, early in the winter of 1917-18 a system was devised whereby dry air under pressure was forced out in front of each gate, so agitating the water there as to prevent the formation of ice.

In general, there are three ways in which pressure from heavy surface ice may be exerted. First, a moving mass of ice may exert pressure by virtue of its inertia. Such an occurrence took place during the winter of 1915-16 at Keokuk. An unusually mild January thaw came while the river was full of heavy ice, which at Keokuk collected in a gorge about four miles above the dam. The pressure of the gorge against the smooth ice cover, about 14-in. thick between the gorge and the dam, finally became too great and the whole ice field, 4 square miles in extent, moved steadily about 40 ft. toward the dam. The gates on the dam withstood the impact without injury, but the shore structures near by were in many cases seriously damaged. Severe cold followed this thaw, and froze the mass of ice in the jam solid, thus arresting any further action for the time being. By the latter part of March practically all of the ice in the lake had melted except the heavy part of the jam. This floated aimlessly about the lake until one morning it was driven down the stream by a heavy wind, acting with the current. The nose of this mass of ice, several acres in extent and from 3 to 6 ft. thick, struck one of the gates squarely and carried it out. It is estimated that to cause such a rupture the ice mass must have exerted a maxmuim force of 92 tons.

A second type of pressure, the author states, may be exerted by ice when it forms on a confined space, and a third type is the pressure exerted by the expansion of a solid field of ice when its temperature is increased. With regard to this third type Mr. Davis says:

> Contrary to the common idea, ice has a coefficient of expansion just as any other solid. In fact, its coefficient per degree F. is .000029, or about four and one-half times that of steel. The range of its temperature is small, however. While the temperature of the upper surface of the ice may be—10° F. at times, the under surface will always be at 32° because of its contact with water. Hence the average temperature of the ice can never be much less than + 11°, and the range of temperature cannot exceed 21°. The expansion in solid ice field a mile long amounts to 3.2 ft. for this increase of temperature.
>
> This type of pressure is not noticeable until the ice becomes solid and from 10 to 12 inches thick. It is first manifested by ice pushed up on the shores of the lake and by ridges of buckled ice running across from shore to shore every mile or so along the river, thus dividing the whole ice cover into fields about a mile square whose centers remained fixed and whose edges are in constant motion while the temperature is changing. An expansion is followed by only a slight contraction when the temperature falls again. Thus there may be an accumulated expansion amounting to 6 ft. or more. A covering of snow on the ice, which to a certain extent insulates the ice from the upper air, will prevent sudden changes of temperature and may, if the snow is 12 in. or more deep, entirely eliminate expansion with changes of temperature.
>
> Such a development of pressure took place at Keokuk in the winter of 1916-17. Heavy ice formed on the lake during a prolonged cold spell to a maximum thickness of about 20 in. A severe cold snap, with a minimum temperature of 18° below zero, was followed by a short rise of temperature to about the freezing point, and under this sudden rise the ice expanded. The rounded faces of the piers tended to break up the ice pressure against them and make the gates take the thrust of the whole ice field. Fluctuations of pond level combined with the enormous energy of the heavy ice field caused local pressure sufficient to deflect permanently three of the gates, the maximum deflection being about 2½ in.
>
> When this condition occurred in 1917 remedial measures were taken by thawing slots about 3 in. wide clear across the front of practically every gate on the dam. This thawing was done by steam discharged through a horizontal perforated pipe half the length of the gate. The slots were thawed quickly in front of the individual gates, but to thaw 119 of them took a crew of six men working continuously more than 36 hours. This practically meant thawing a continuous slot over two-thirds of a mile long. Hence this way of relieving ice pressure could be considered as a practical method only in an emergency, but it relieved the serious situation. Immediately thereafter a set of experiments was started to discover the feasibility of using air to keep ice from forming in front of the gates, the idea being to discharge air under water at the middle of each spillway, so that the circulation would keep the water open in front of the middle of each gate.

SURPRISING EFFECT OF THE AIR

The tests were made on ice ranging from 10 to 22 in. thick. The work which a very small amount of air could accomplish when discharged under a considerable depth of water was surprising. The explanation of this action

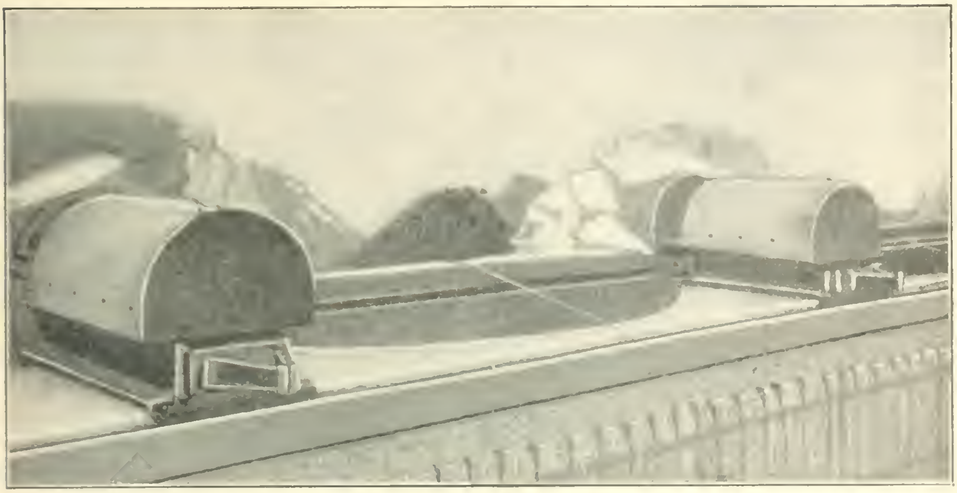


FIG. 2. LOOKING DOWN ON BACK OF DAM

is not that the air brings up warm water from below, but that it creates a circulation which keeps water, always at a temperature above freezing, passing continuously by the ice edges. A column of water rises with the air and flows radially from the point where the air bubbles break the water surface.

It was found that a little less than 2 cu. ft. of free air per minute would keep an area 20 ft. in diameter open at an air temperature of O° F., if discharged vertically upward at 18 ft. depth in a period of about four days. It was also found that for temperatures below freezing the amount of melting was directly proportional to the depth of the air, and that a change of air temperature changed the open water area by roughly 3% per degree F. over the ordinary range of freezing temperatures. An orifice calibrated to gage pressure was used to measure flow of air during the tests.

These tests proved so satisfactory that a complete system was designed to carry out the idea as evolved. The system had a sufficient capacity to furnish a maximum of 2 cu. ft. per minute of free air to each gate. The compressor was selected with sufficient capacity to supply the maximum demand on the dam, and in addition to furnish as much air again for use in the power house. This installation was completed and ready for operation a few days after the lake froze over in early December, 1917. Its total cost was well within the estimate of $9500. The installation is described as follows:

The pipe main is 2 in. in diameter from the power house east for a distance of three-fifths of the length of the dam, and 1½ in. from that point to the last spillway. It was designed by Johnson's formula to carry 2 cu. ft. of free air per minute to each of the 119 spillways with an initial air pressure of 80 lb., and a terminal pressure of 55 lb. Actual losses in operation have checked in general the computed values. Six expansion joints with a total travel of 90 in. are provided for the total length of the main, which is 4270 ft. An anchorage is placed half way between the expansion joints.

Probably the most important feature of the layout of equipment is the method employed to dry the air supplied to the outdoor system. As known, moisture in air lines out of doors is a fruitful source of trouble during cold weather. With this system especially it would be serious, because any stoppage in the air would allow water to freeze quickly in the discharge pipes where they enter the water. To get the system at work again all of the frozen discharge pipes would have to be removed and thawed individually. To dry the air an aftercooler, capable of removing two-thirds of the moisture-content of the air passing through it, was installed in the pipe line just before it passed out of doors. It cools the entering air by cold water coils and removes the moisture by condensation.

As a further aid in drying the air, the system was designed to reduce the air pressure from 125 lb. to about 75 lb. gage through a pressure regulating valve. The resultant cooling of the air causes further condensation and drying. To date, however, this regulating valve has not been operated as an agent in drying the air, but has been operated to secure variable pressures in the main on the dam as an aid in adjusting the whole system to climatic changes, it having been found that the after-cooler dried the air sufficiently to prevent freezing in the most severe weather.

A ⅜-in. needle point valve at each spillway controls the flow of air through the ⅜-in. pipes which discharge the air. As the system has finally been laid out these are set so that they discharge vertically upward about 1 ft. in front of each gate and normally at a water depth of 10 ft. This produces a semicircular area of open water in front of the gate. It was found that the air when discharged at 18 ft. depth was too effective for convenient regulation by the small valves.

The motor driven compressor which furnishes the air for the system is a two stage machine, with air cylinders 17 and 10 in. diameter with a stroke of 12 in. and a free air displacement of 570 cu. ft. per minute at 181 revolutions. It has double the capacity that should ever be required for the dam.

The open water areas have been at all times under the easy control of the small needle valves at the top. These valves seldom need adjustment more than once a week, since a great deal of the regulation can be handled by the pressure regulating valve in the power house. An inspection is made every day or two in the severest weather to make sure that all pipes are working. The expense of labor for maintenance of the entire system for the winter will be less than $150.44.

The installation through the extremely severe weather of 1918 was most successful. The views show the conditions early in this year. There had been a movement of about a foot toward the main field of the dam, and ice had commenced breaking up at the piers. The gate is free from any pressure, as a consequence, on account of the open water area at the center. A bearing is kept against the dam, centering on the pier. Ice formed during January last to a maximum thickness of 25 in. in the open lake, and the results shown in the views have been obtained by the use of about 1 cu. ft. of free air per minute. The maximum capacity of the system has proved sufficient to melt ice from the face of the ice field faster than it can move toward the dam under ordinary expansion. Since the system was thoroughly in operation there has not been a single stoppage in the pipe main or the individual pipes due to freezing, and the system has passed through the most severe conditions that it will ever experience.

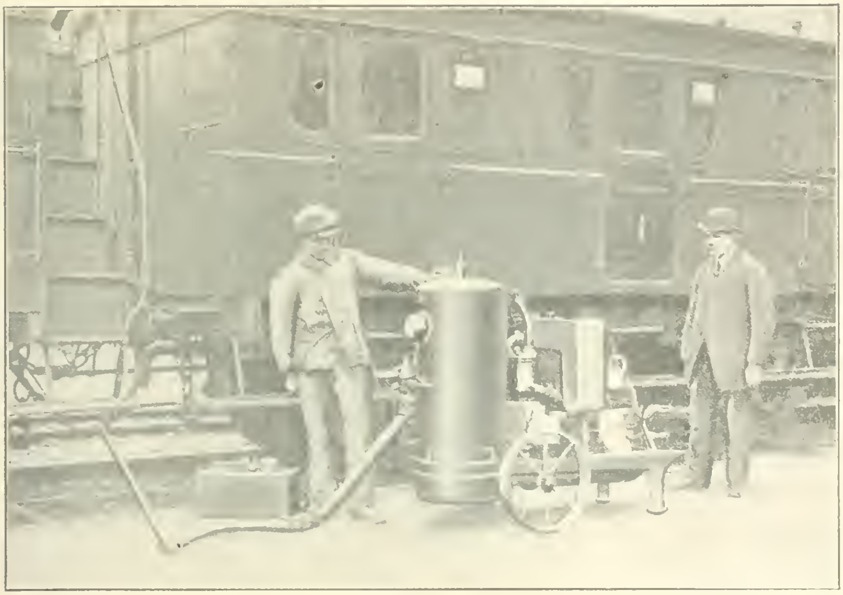
VOMITING GAS

Chloropicrin (Vomiting Gas) was prepared by Sthenhouse as early as 1848. The method he employed was to treat a solution of picric acid with bleaching powder; and, while there are a number of other ways of preparing it, this original method is the one used in preparing it on a large scale.

Chloropicrin, like many of the other so-called war gases, is a high boiling liquid. It is generally used in mixtures with other "gases," and, because of its high boiling point it is nearly always used in artillery shells or bombs. It penetrates the masks and respirators more readily than most other gases and produces nausea or vomiting, thus forcing the removal of the masks. It is an active lachrymator and is used for this effect also. There are records of it having been combined with chlorine and used in cloud attacks. It is a violent poison, in high concentrations it causes blindness, and in extremely slight concentrations it is very painful in its effect on the eyes.

In direct contact it produces painful, slow-healing burns, and deep abscesses. It is an exceedingly stable substance being only slightly attacked by water, chlorinating agents, soda-lime and many other active chemical reagents. It is this property which makes it so difficult to absorb in the mask; in fact, it is only mechanically absorbed by the charcoal in the mask, and is not affected by the chemicals at all. It is a remarkable fact that such a chemically inert substance should be so toxic. Most substances gain this property by virtue of their great avidity.

Its high boiling point makes it a valuable substance to scatter about since it soaks into the ground and persists for a long time. On the other hand it is volatile enough to keep the strata of air above it thoroughly poisoned. It has been used by both the Germans and the Allies. At the present time the United States probably is producing more than any other country.



FOR TESTING TRAIN BRAKES

PORTABLE RIG FOR TESTING TRAIN BRAKES

A French inventor, M. Campagne, has just constructed an apparatus, a view of which is here reproduced from the *Scientific American*, for testing the entire brake apparatus of made-up trains. The arrangement comprises a motor and an air compressor mounted on a hand truck. As the view shows the motor is a vertical one, of automobile type. It is of one cylinder, water-cooled, developing five horse-power; the bore is 3.6 inches, the stroke about 4 inches, and the maximum speed 1,200 revolutions per second. The compressor is geared down from the motor to operate at a speed of 650 revolutions. Motor and compressor are supplied with fuel from a common reservoir, and employ a single radiator. All parts which can possibly be made so are interchangeable, so that there is little or no probability of the assembly being put out of commission for any length of time by a breakdown.

The French railroads which have tried out M. Campagne's apparatus report that with it, one man can test all the brake connections of a train in a half hour, instead of twice that time, as formerly; and the tests can be conducted in the absence of an engineman, which was not the case when the several connections had to be brought opposite a stationary compressor. The device has been adopted by the State Railroads, as well as by the Orleans and the Eastern lines.

HOME LIFE AT THREE MINES

A recent bulletin of the School of Mines and Metallurgy, University of Missouri, comprises an advisable address by James Furman Kemp, Professor of Geology, Columbia University, entitled "The Human Side of Mining Engineering." The following is a little sample of the address.

Mining and metallurgical enterprises in a large proportion of cases differ from other industries. They are often in remote places. The community is built up around the mine or group of mines or around the smelter. The manager must not only employ and pay, but house, feed and educate. Let me give you one of two illustrations, not necessarily drawn from America. When the International Geological Congress of 1910 was held in Stockholm, Sweden, an excursion was given the delegates far to the north to the great iron mines at Kirunavaara, situated over a hundred miles north of the polar circle in Swedish Lapland. At Kirunavaara—under the leadership of Dr. Hjalmar Lundbohn, formerly of the Geological Survey of Sweden—a huge sheet shaped mass of magnetite had been developed, that is very nearly if not quite the largest single body of iron ore yet discovered the world over. A remoter situation could hardly be conceived, nor, in winter, severer climatic conditions. From a great though somewhat diversified plain there rises to a height of some hundreds of feet the ridge whose backbone for several miles is the great sheet of iron ore, lying with a dip of 70 degrees between other sheets of contrasted eruptive rock. At the foot of the ridge in 1910 a community of five thousand souls had been established. There were a thousand children in the schools, and the school-houses in which the eight or ten score excursionists were fed were beautifully constructed and equipped. The houses of the workers were comfortable and convenient so that to the most superficial observer it was evident that Dr. Lundbohm had been moved by an almost pastoral care of his flock.

On the day on which we were conducted along a amile or more of the outcropping ore and while the other members of the party were busy collecting from the ore, the hanging wall and footwall, I sat for a brief space apart by myself and studied over the Arctic expanse of stunted trees, moraines, swamps and lakes. But continually my thoughts would come back to those five thousand people, men, women and children, all drawing their support from the mine. There they were, placed right in the hand of the General Manager, and his opportunity as well as his responsibility for more than food and clothing were very great. There was a little, organized state in miniature, and much more than Swedish kroner in dividends was involved in the way their lives were directed.

Let me ask you to turn your eyes next to the West for two more illustrations. The flourishing little city of Anaconda, Montana, gathers around the Washoe Smelter, or as the company now officially calls it, smeltery. You could not be a half-hour in Anaconda without hearing the name of E. P. Mathewson, until recently the manager of the works, and now moved by the exigencies of the war and his Canadian citizenship to develop a new company for the production of nickel in the Sudbury district, Ontario. But Anaconda is Mr. Mathewson's masterpiece—and we see not alone a great and thoroughly organized smelting plant, but good homes, good roads, a park, a fish-hatchery, and a hundred other signs of wise and far-sighted management. One also finds a singularly devoted staff of workers, reaching into the thousands and animated by one spirit of loyalty. We understand why the Mining and Metallurgical Society of America awarded its gold medal to him in 1917. Mr. Mathewson passed on to his successor not alone the management of the great works but responsibilities not unlike those of bishop of a diocese.

Were you to go farther west to the valley of the South Fork of the Coeur d'Alene river, deep down between the mountain ridges of Idaho, you would find the trim little town of Kellogg, centering about the mines, mill and smelter of the Bunker Hill & Sullivan Company. Homes for the workers with a plot of ground, which can be bought from the company under favorable terms, are the striking feature to a visitor. Instead of the slovenly cabins, and unattractive boarding houses so often the rule in western mining camps, one notes comfortable homes with little gardens in which a miner and his family may take pride. In these as well as in other ways in connection with this mining enterprise, the wisdom of Mr. Stanley Easton's far-sighted management becomes impressed on an observer.

DRAINING AIR PIPING FOR PNEUMATIC TOOLS*

It is the object of this communication to call attention to the importance of providing for effectually separating and draining the water of condensation from the piping system of pneumatic tools.

The slugs of water frequently coming through the pipes, in the general run of plants, not only interfere with the momentary operation of tools, but cut out the valves, cylinders, and wash out the oil, seriously interfering with lubrication. The water cannot be properly taken care of merely by placing drain cocks on low points in the ordinary piping system, but should be removed by special separation tanks or chambers located at these points and near the distributing manifolds. The separators will also serve as collectors of scale and dirt coming through the pipes, and the

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*Standard Practice Bulletin, Emergency Fleet Corporation.

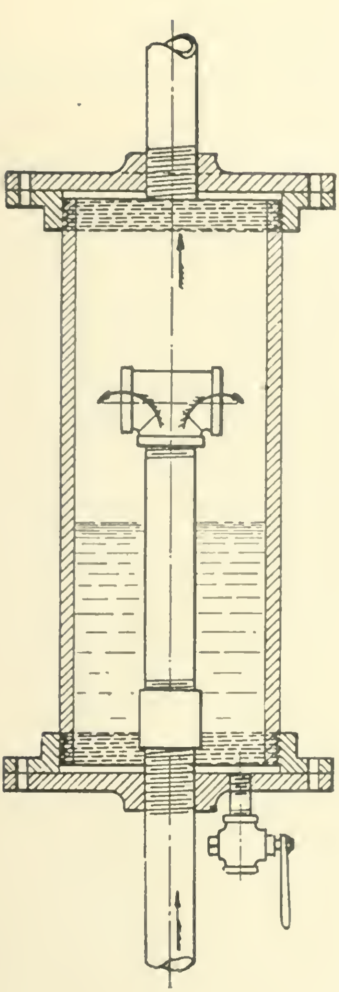


FIG. 1

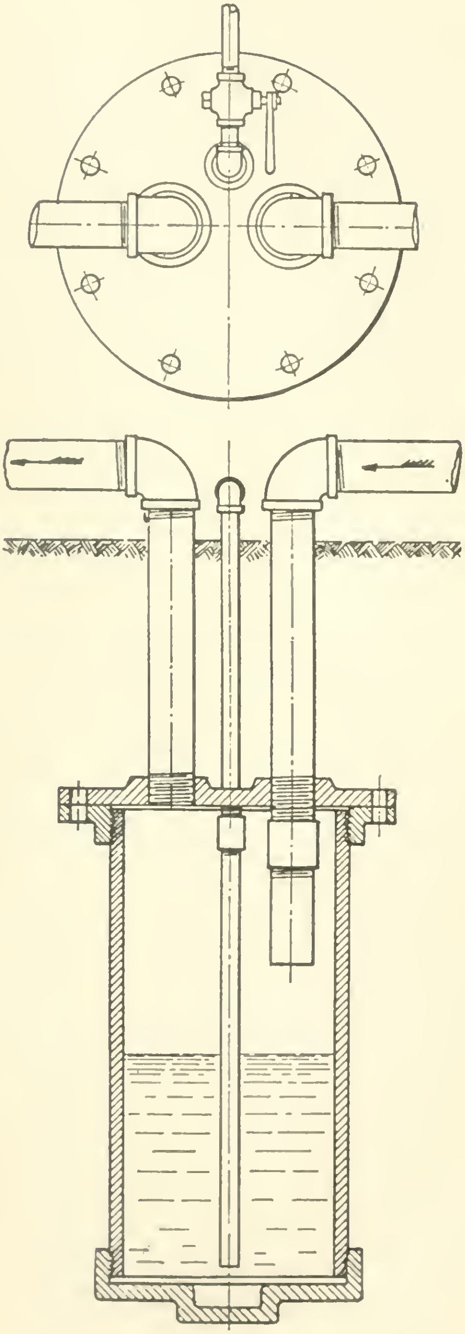


FIG. 2

drain or blow-out valves should be large enough to discharge these matters as well as the water.

The separating chambers should be large enough to lower the velocity of the air to a point where entrained water or dirt will not be carried through with the air current, and should be fitted with bafflers or connections which will change the direction of flow, so as to precipitate the entrained matter.

While the arrangement of separators will necessarily be governed by the piping layout in each individual installation, the accompanying cuts, Fig. 1 and Fig. 2, illustrate two types, which in the smaller sizes can readily be made up of standard pipe fittings. Fig. 1 shows a type suitable for vertical risers at the ship staging, while Fig. 2 indicates a type suitable for horizontal distributing lines.

An air piping system should be uniformly graded with the direction of flow, so far as the main runs are concerned, and should always have separators at or near rising points. Sags or pockets without separators for the accumulation of water should never be permitted.

Where it is possible to do so, separators on outdoor lines should be placed in the ground below the frost line, to prevent freezing, as shown by Fig. 2. The condensation can be blown out through a vertical discharge pipe by the pressure of the air in the separator.

EUROPEAN BURNERS FOR PITCH AND TAR

In the processes of gas manufacture considerable quantities of tar and pitch are recovered as by-products. Under proper conditions these can be burned directly under the boilers or under the retorts as fuel. The combustion of these fuels is made possible through finely dividing by spraying through the use of special burners. One of these European burners is known under the trade name of "Omega." These burners enable the combustion of petrol and of heavy oil fuels, but also of such combustibles as crude tar and the soft pitch. Fig. 1 gives an idea of the principles embodied in the "Omega" burners.

The fuel reaches the combustion chamber in the form of one or more thin streams (in the illustration there are two streams). It enters the burner through an opening a, and its outflow is regulated by the spindle valve b. The liquid, vapor or compressed air which produces pulverization enters through the conduit c, from where it passes on the one hand into the central tube d, and on the other hand into the ring-shaped space e. The liquid flows out in the form of two cylindrical layers, separated by the wall f. The liquid or air used for pulverizing or for forming the fuel spray is introduced into each of the fuel layers by orifices pierced obliquely in the walls of the burner. Besides, the liquid layers are divided into still finer layers or sprays by the use of the ribs i and j. The Qmega burners are constructed in four different forms, two each, however, based on the same principle.

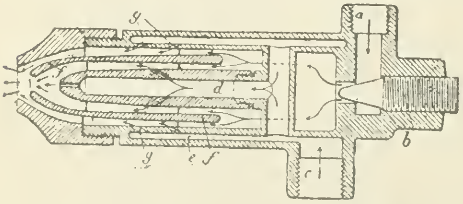


FIG. 1. SECTION OF OMEGA BURNER

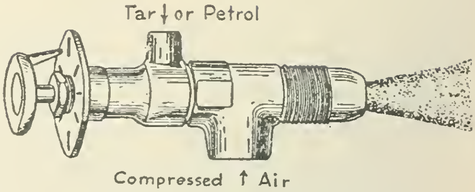


FIG. 2. OMEGA BURNER TYPE I

The burners using low pressure, working with the aid of compressed air below 25 cm. (9.75 in.) water column, requiring about 1500 liters (45 cu. ft.) air per liter (0.03 cu. ft.) of pulverized petrol. For crude tar or hard pitch the pressure is near 80 cm. (31.20 in.) water column and the quantity of air for pulverizing this fuel is about 3000 liters (90 cu. ft.) per liter of pulverized fuel. The rest of the air needed for combustion is drawn in by the burner with the aid of a split tube which is attached to it or by means of an air valve (Fig. 2).

Another type of low pressure burner also using compressed air (Fig. 3) uses compressed air below 25 cm. (9.75 in.) water column; these burners use about 10-12 cbm. (353-423.6 cu. ft.) air per liter of the fuel. In order to pulverize tar or hard pitch this type of burner requires about 50 cm. (19.5 in.) water column pressure. These burners are provided with a double valve system, which governs the air supply. For each position the burners work without excess of air.

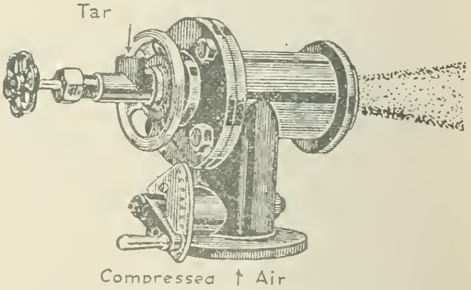


FIG. 3. OMEGA BURNER TYPE II

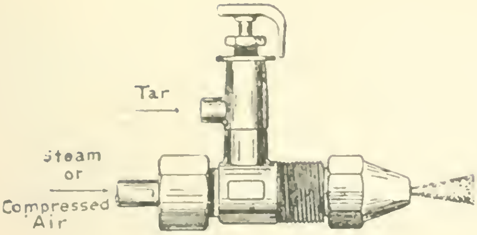


FIG. 5. OMEGA BURNER TYPE IV

The burners shown in Fig. 4 work either with steam under pressure or with compressed air, somewhat analogous to the steam jet vaporizers. They draw in the fuel by themselves and can be used to work with ½ atm. of pressure. They consume about 0.3 kg. (0.66 lbs.) of steam or 600 liters (18 cu. ft.) of compressed air per liter of pulverized fuel.

The burners shown in Fig. 5 work either with gas, with air or with steam compressed to 1.5 or more atmospheres. They consume about 100 liters (3 cu. ft.) of gas under pressure per liter of pulverized fuel. The fuel must be supplied to these burners under fairly high pressure, usually between 1.5 and higher atmospheres.

The two important applications that interest us in the question which we are considering are:

1. The possibility of using Omega burners for direct burning of tar under boilers. 2. The possibility of using these burners for direct use of tar or pitch as fuel under retorts in gas works. These burners can be used for heating either boilers or gas works retorts, locomotives or steam vessels. They have been used in several large Swiss and French plants with great success, not only from the standpoint of economy, but also from that of good functioning. They allow the utilization of sluggish fuels, such as tar and pitch represent, with a maximum caloric power and without danger of interruption of operation through mishaps or clogging of burners. Tests carried out for a long period of time by the Sulzer plants at Winterthur in Switzerland and by the gas works at Geneva have shown the practicability of this operation and the economy as well as the freedom from accidents when using this type of fuel in these burners.

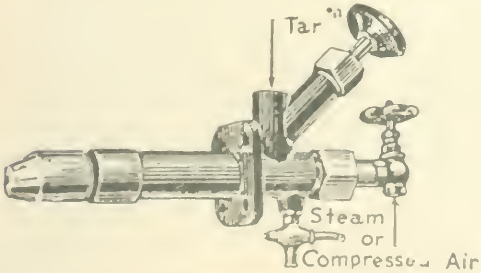


FIG. 4. OMEGA BURNER TYPE III

Lighting of the burners, if no other kind of gas is at disposal, can be accomplished by means of some compressed gas like hydrogen, passed to the furnace room from steel cylinders. Or else compressed air can also be used, furnished by a small compressor, and this can furnish the needed air pressure for further operation of the burners, once they have been lighted.

For heating the retorts in gas works the illuminating gas produced in the gas works can be used as a heating medium for the burners. This gas can be compressed to three or four atmospheres by a special small compressor. As in this case the consumption is only about 100 liters (3 cu. ft.) gas per liter of pulverized fuel, operation is very economical. During tests made at the Zurich gas works in Switzerland with Omega burners for heating of a large superheater, it was found that pitch could be substituted with great economy for the tarry oils that had been used previously for this purpose. Care must be taken that the temperature of the compressed air used in the burners for pulverization is higher than the fusion temperature of the pitch. It was observed that melted pitch is fully as fluid and mobile as the tar at the temperatures at which it is ordinarily used for fuel.

These Omega burners are being welcomed for the direct burning of pitch and tar, especially if we are going to follow a policy of utilization of by-products to as full an extent as was pointed out before It seems a good plan to recover every possible by-product that can be recovered from the oils that possess such by-products and not use these as fuels. The coke ought to be kept separate as fuel and likewise the tar and pitch, especially the latter, and the other oils ought to be treated for their by-products to the fullest extent. Up to now pitch has not been fully appreciated as to its fuel value by gas works, witness of which is the fact that it has been used to most part for such things as macadamizing of roads, making of roofing paper, electrodes, briquets, etc. It is obvious that the possibility of using it under furnaces and retorts as fuel is of such an economic advantage, that its use for the other purposes will be more and more restricted.

Manganese acts as a catalyst in the fixation of atmospheric nitrogen by plants through the aid of bacteria. Tests by A. de G. Rocasolano show that the nitrogen-fixing bacteria, grown in pure culture, do not fix nitrogen when manganese is absent. The highest amount of fixed nitrogen is obtained when 0.006% of Mn. in available form is present.

HEROES UNSEEN

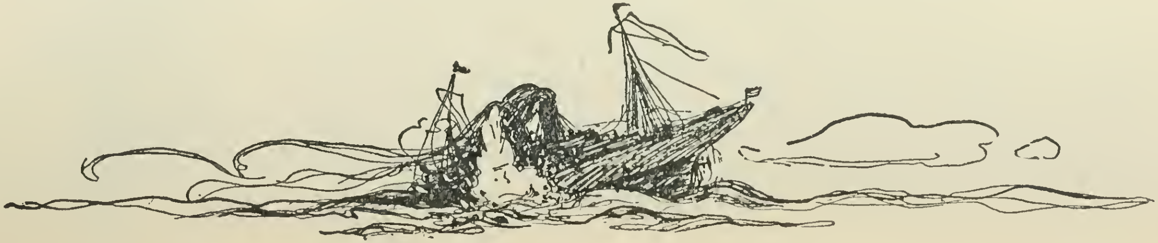
by Frank Dorrance Hopley

The power that turns the night to day,
That drives the wheels in workshops gray,
And brings the ships into the bay,
  Is wrought by human hands.
In stifling rooms, away from sight,
Amid the dirt, from morn till night,
Men stoop to labor with their might,
  Fulfilling all demands.

They sweat and grind, fall ill and die,
And others come, as time goes by,
To labor on, without a sigh,
  Parts of a great machine.
No cheers are theirs, no flags are flung,
Their splendid courage is unsung,
Their names are not on every tongue,
  These men who work unseen.

The fireman and the engineer
On ocean vessels, without fear,
Beneath the decks, though foes are near,
  Work calmly every day;
They brave the submarine's quick blow,
Which oft brings death to those below;
There is no honor we bestow
  Too great for such as they.

We laud the soldier as he stands
On battlefields in foreign lands,
The sailor, who, within his hands
  Our safety holds this hour;
But as we sing our hymns of praise,
We'll not forget those who always
Work on, afar from human gaze—
  The men who make the power



—*Power.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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APPRECIATION

We feel that we owe the United States an apology for the false impression that has prevailed in certain quarters here as to America's aims and objects at this particular time—an impression which recent events has blown to the four winds of Heaven. Many of us had thought that America was so intent on making money out of the war that she would never rise above sordid ideas, and that her part in the struggle would be confined to protests without logical conclusions and Notes without acts. Those who entertained such notions in the early part of the war do not do so now. America, led by her noble President, who will rank hereafter with Washington and Lincoln, has risen to the full height of her great opportunity, and responded to her noblest impulses. Casting every thought of self on one side, and inspired only by the interests of justice and humanity, she has thrown herself into this ghastly war with an abandon which has hardly ever been equalled and perhaps never excelled. Some of us did not know America in the old days; we know America now. The New World has indeed stepped in to redress the balance of the old, and history will tell how much civilization and liberty have owed to the greatness of America's sacrifice and the splendour of her achievements.—*Mining World*, London.

AN ENDING AND A BEGINNING

The above was published in England a month before the Armistice so suddenly put an end to the World War, and, in fact, it was in type for our own page before that event. It needs not to be said that the status thus accorded our nation and its honored head was by the outcome of the fighting decisively confirmed. We have not only received a distinguished service badge but have been promoted in rank to the front of the World Nations.

The end which was reached by the crushing of the foul aggressor and the overwhelming of his pirate crew was complete enough. There was an absolute finish of things as they were; but there was at the same time a beginning, and for none more than for America, of a new order of things. To-day it were only a reckless prophet who could hope to keep pace with the events which now crowd the record. We only know that none but the optimist can have a chance.

We may assume to be assured of world peace for a generation, but not a peace for the folding of the hands or for comfortable dozing. There must be a slight pause for us to catch our breath and to recover from the sharp fatigue of the moment, but then must come a more strenuous life and a fierce joy in planning and achieving. We may not take up our life activities and our productive industries where we left off, for while things left undone have accumulated, new things that belong to a larger life have shaped themselves for the doing.

The minor details of readjustment entailed by the complete resumption of the ways of peace will be little helped by any anxious contriving, and must soon and automatically adjust themselves. There will be place for every returning soldier practically at once, and not only will there be work enough for all but we will be inviting and welcoming hordes of immigrants to take the heavier burdens to which their backs will be more accustomed. The period of high wages will have left its mark in the living habits of the people, so that all will be expecting and appropriating more of the good things of life, and thus we will have been developing our own customers and enlarging our markets at home.

While the unfortunate nations of the Old World will be recovering and recuperating we will be growing and expanding. Our need of foreign products will have been reduced by the development of our own facilities which the war has compelled, and thus in the directions of both supply and demand we must learn more and more what independence is. It is with no disposition to boast or to provoke envy or jealousy anywhere that this view is presented, but simply to call attention to the facts as they are. We are not beyond the possibilities of great internal troubles of our own, but these we may hope to happily solve when they come upon us.

Take a mailing tube, say, 18 inches long and two inches diameter. Put your mouth at one end and blow through it and feel the effect of the blast on your hand at the other end. Now hold the tube about an inch from your mouth and blow into the end of the tube. You will be surprised to feel the increase of the effect at the other end.

The shock of exploding gunpowder will not detonate gun-cotton, picric acid, T.N.T., or nitro-glycerine. The shock of detonating nitro-glycerine will not detonate gun-cotton. The shock of detonating gun-cotton will detonate nitro-glycerine. Gunpowder is incapable of detonation. Fulminate of mercury will detonate all the above, with the exception of T.N.T. cast into slabs, but with the addition of a little lead azide will detonate them fully. Increasing the quantity of the initiator of detonation above a certain minimum has little effect. One gramme of fulminate will detonate an unlimited amount of picric acid. No amount of gunpowder would do it. A fulminate detonator provides combined shock and sudden heating, and is, therefore, very effective.

NEW BOOK

The A. B. C. of Aviation, by Captain Victor W. Page, Sig. R. C., A. S., 286 pages, 5½ by 8½ in., 130 illustrations. Norman W. Henley Co., New York. $2.50.

This is a most timely book, for it may well be believed that we are only at the beginning of practical aerial flight either for business or pleasure, and the time is not distant when a general knowledge of aviation will be imperative. No one could have been found better qualified to prepare such a book as this and the result is most satisfactory. All types of aircraft are described, their principles of operation and the modes of manipulation and control. Detailed drawings of the various types of airplanes are given, there is a full dictionary of aviation terms and the book is completely indexed.

An inventor of Paterson, N. J., has perfected a loom which will weave diagonal reinforcing threads into cloth to be used for tire fabrics, thus greatly increasing their tensile strength and at the same time preserving their flexibility.

THE PNEUMATIC TOOL AND THE WORKMAN

By Francis M. Barnes, Jr.*

The introduction of mechanical tools into the trades has been accompanied by numerous actual and claimed damages to their operators and also a more or less direct cause of the occurrence of new and particular diseases or the factor predisposing to the incitement of ordinary diseases in greater prevalence. Among such mechanical tools the pneumatic hammer, in comparatively recent years, has come to occupy a most important position in several lines, notably in shipbuilding and in the steel and stone industries.

Within the past two years complaints of ill effects from the use of the hammer have become prevalent although these do not seem to have originated so much with the individual user of the hammer as with labor organizations of which he is a member. It has been claimed that the use of the hammer produced in the men a diseased condition affecting the nervous system and leading even to paralysis, insanity or other form of complete incapacitation.

In view of the fact that in current medical literature no mention of such diseased condition from this causation could be found it became necessary to carry out an investigation to determine, if possible, whether such disease actually did exist, its extent and seriousness, and, if necessary, to study measures whereby its occurrence could be minimized or entirely done away with. Such a study is obviously of importance, not only to the workman, but to the operator whose interests are more broadly involved.

Recent investigations have been carried out in parts of the country where the pneumatic hammer is used in shipbuilding and in the steel industry. From reports of such investigations as are available it was not found, in any instance, that the use of the pneumatic hammer produced any deleterious effect upon the general health of the workers.

So far as this study is concerned the men using pneumatic hammers on limestone were found to be in good general health and none of the group examined showing any constitutional disease; their troubles (supposedly arising from use of the hammer) being limited to a disturbance of the function of the left hand—commonly known as "white fingers" or "dead fingers." As a general thing this condition occurs shortly after the men first go to work in the morning, or until they have "warmed up," although it also occurs during cold weather when the hands are exposed otherwise than in working.

First the little finger and ulnar side of the left hand (in right-handed men) become pale and blanched; the same area soon giving rise to tingling or numbing sensations, sometimes even to slight pain. The ring finger and part of the middle finger may also be involved in this process. By swinging the arms or rubbing the hands the condition may be made to disappear and when the hands are warmed the pallor rapidly gives place to diffuse flushing and reddening. The index finger and thumb of the right hand are occasionally affected, particularly in those workers who improperly control the exhaust by their finger or thumb.

So far as could be determined this condition of the hands constitutes the sole trouble from which the stone workers complain in so far as the pneumatic hammer is concerned. In all of the workers examined the hands were somewhat reddened and flushed, but not more than reasonably might be expected in the hands of outdoor workers. The hands were calloused to a varying degree in different subjects, but in all quite extensively. The palm and certain of the fingers of the left hand were more calloused than on the right. There was no actual cyanosis, excepting in one subject, where this was slight. No swelling, no tendernesses, no pain, no edema and no involvement of the muscles or joints. Paresthesia was absent excepting in one subject, who reported some numbness in his "white fingers." This was the only subject to show the condition well developed. Sensation for all tests was acute and practically normal. In most subjects there was a lowering of acuteness of feeling—some blunting or dulling—but this certainly was no greater than could be expected in hands where so much callous was present. In all but one subject the callous was sufficient explanation for any variation from the normal which could be observed in sensation. In this one subject the sensory disorder passed off in a few minutes or as soon as the hands became warm. Mental disease was not present in any subject examined, nor was there any physical disease which could in any way be attributed to the occupation.

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*From a paper presented at the Safety Congress of the National Safety Council, St. Louis, Sept. 18-19.

Such disorders of the extremities indicate very clearly that a disturbance of the peripheral circulation of the blood is responsible for their occurrence. The calibre of the peripheral blood vessels, and therefore the amount of blood supplied to the part, is dependent in large measure upon the action of the nerves which supply these blood vessels, known as vasomotor nerves. Low temperatures stimulate the sensory nerve fibers in the skin and the nerve impulses thus aroused reflexly stimulate the vasoconstrictor center, or a part of it, and cause blanching of the skin. That cold may produce evident changes in the appearance of certain parts of the body, notably of the extremities—the feet, hands, ears and nose—is a matter of common observation.

It has been pointed out that exposure of the hands to cold usually produces at first a pallor of the skin which is evidently due to a constriction of the cutaneous arterioles. When the exposure is prolonged, however, the color is heightened and the skin usually becomes more or less cyanotic. Almost universally, therefore, cold produces a constriction of the cutaneous arterioles and a slow flow of blood through the skin. The variations in color are thus caused by the varying amounts of blood that collect in the skin capillaries. The flow through the blood vessels is also in part influenced by the muscles which surround them. Anything, therefore, which interferes with or impedes the normal action of the muscles will have its effect in turn upon the circulation, as it is the changing state of contraction and relaxation of the muscles which aids in the flow of blood under normal conditions. Where a group of muscles is held in a contracted state for a considerable length of time the circulation is thereby impeded.

With the workman, whether using a chisel and mallet or a pneumatic hammer, the factors of cold, continued muscle contraction and cutaneous irritation are all present to a considerable degree and demand due evaluation in the consideratoin of such disorders in the hands as are sometimes observed. The fact, borne out with uniformity in this investigation, that the trouble occurs only in cold weather indicates most conclusively that the low temperature itself is one of the most important factors in the causation. The continued muscular contraction and the mechanical irritation (vibration) may play a role in its causation, but evidently these are of secondary importance.

The fact that the trouble, when present, preeminently affects the left hand, which holds the chisel and not the hammer, indicates clearly that other factors than the hammer itself are of more signal importance in its causation. The cramped position of the chisel hand with the more or less continuously maintained contraction of the muscles is one of these important factors. However, the hammer or the grip of the chisel, either alone or combined, are not sufficient to produce the condition, as is proved by the fact that it does not occur in the warmer seasons of the year when industry is at its height. The role of the vibration is uncertain, but as the trouble occurs in the hand not holding the hammer, it is doubtful if its importance is very great. We have left, therefore, the factor of low temperature which seems to be the final and most important element in the production of those vascular changes seen in the hands of some workers which, although physiological in nature, form the pathological basis for the occurrence of "white fingers" and "dead fingers." So far as can be ascertained the condition leads to no permanent disability and results in no organic disease. Why it is that only a portion of stone cutters are affected cannot be answered. Whether certain undetermined conditions of poor general health or specific diseased condition existing, but not recognized, predisposes certain men to this disturbance is not evident from this investigation, although apparently such is not the case. With one or two exceptions they were all well developed, robust men without demonstrable general physical or mental disease.

DRAWS INTERESTING CONCLUSIONS

Conclusions drawn from a comparatively small series of observations must be subject to some limitations. However, the uniformity of the results of the examinations made in this investigation, taken together with the testimony of the workmen and of others, reasonably justifies the following deducations:

1. Structural steel workers, ship-builders and stone cutters as a class, enjoy good general health and are not, because of their trade, espe-

cially susceptible to any particular disease.

2. Stone cutters are liable to a disorder affecting the hands, especially the left hand.

3. This disorder of the hands is of a vascular character, not due to organic changes in the circulatory system, but dependent upon vasomotor reactions.

4. These reactions are physiological in character and are occasioned by three factors incident to the work of stone cutting: Mechanical irritation of the skin, continued muscular contraction of a cramping nature and low temperature.

5. Of these three factors, cold is considered the most important because the condition only occurs during the severely cold weather and never in the summer, and warmth and measures to restore the circulation (rubbing, swinging the arms and the like) cause its disappearance.

6. It cannot be caused by the effect of the air hammer alone because it occurs in those who have not used the air hammer. It does not occur in warm weather when industry is at its height and, therefore, when the air hammer is most in use. It occurs mostly in the left hand and not in the right hand in which the hammer is held.

7. The vasomotor disorder is of temporary duration and is not known to have resulted in permanent disability of the hand, nor itself to have been the cause of development of any other local or constitutional disease.

8. It is possible that once having occurred the person is rendered more susceptible to its reappearance, just as is the one who had had his ears or fingers frostbitten by the cold.

9. There is no sufficient reason in the signs and symptoms presented in this disorder to conclude that one has to do with Raynaud's disease, acroparesthesia, neuritis or an occupational neurosis.

10. The institution of measures to warm the chisel before and while using, enlarging the shank of the chisel and covering it to make it possible to hold without so cramping a grip, the wearing of gloves, and the discontinuance of the prevalent custom of blocking the exhaust outlet, and thus forcing a draft of chilled air out along the chisel and onto the fingers of the left hand would do much toward the prevention of this trouble.

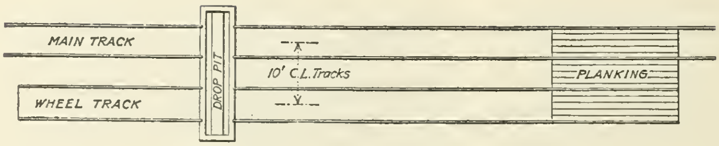
Vienna tramway conductresses are dressed from head to foot, including boots, in paper.

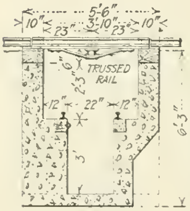
ARTIFICIAL SILK

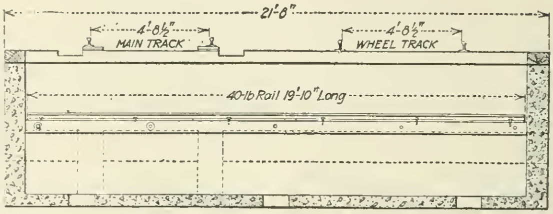
Artificial silk is becoming an article of importance in the world's industries. For instance the cost of the artificial silk yarn used in the United States in 1899 was $10,380; in 1904, $1,623,000; in 1909, $1,927,000; in 1914, $3,440,000; and in 1917 presumably more than $25,000,000.

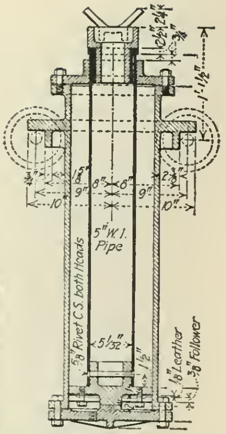
The process of turning trees into silk stockings through the transformation of wood pulp into cellulose, from which to produce the artificial silk threads, is comparatively simple. The wood pulp is treated with caustic soda to form a sodium cellulose and this is then dissolved in carbon disulphide. The product, alkali-cellulose-xanthate, is a viscous solution popularly called "viscose;" and, after being filtered and allowed to ripen by standing, it is forced through minute openings in a metal plate into a liquid which solidifies the threads, which are, when completed, similar in appearance, dimensions and chemical qualities to the fiber produced by the silk worm itself. Indeed the substitute is almost exactly identical with that carried in the body of the silk worm from which he spins the cocoon which man transforms into silk threads.

ONION CONQUEROR









AIR JACK FOR CAR WHEEL DROP PIT

By F. G. Lister*

The car wheel drop pit shown in the accompanying illustration has been in use at the various terminals of the El Paso & Southwestern System for about three years. It has proved to be a means of saving much time and expense in removing and replacing car wheels, as it does away with the necessity for jacking up the car and trucks when wheels are to be changed.

The essential features of the construction consist of a pit 3 ft. 10 in. wide by 2 ft. 9 in. deep which is bridged by two trussed rails in the track. A wheel track to facilitate the bringing of wheels to the pit and removing them for repair is located alongside the main track and the pit connects these two.

At the bottom of the pit and extending across these two tracks is another narrow-gauge track. A jack provided with wheels to support it and to facilitate its movement runs on this track. To remove a pair of wheels from a car it is only necesary to run the car across the pit until the wheels which it is desired to remove rest on the center of the trussed rails. The jack is then run underneath the car and raised to support the wheels and lift them slightly so that the trussed rails can be removed. The jack is then lowered with the wheels and run along its track until in line with the wheel track where it is again raised, and by applying the trussed rails to the wheel track the wheels can be rolled out of the way.

---

*Mechanical Engineer, El Paso & Southwestern System, in *Electric Railway Journal.*

A FIVE-AND-A-HALF MILE CLIMB IN AN AMERICAN AIRPLANE

It seems reasonable to suppose that the recent world's altitude record of 28,900 feet established by Capt. R. W. Schroeder, U. S. A., at Dayton, Ohio, will stand for many months to come. And so the record stands today as the achievement of an American aviator, carried by an American-built airplane, and propelled by an American-built engine.

For his record climb Captain Schroeder used a single-seater Bristol fighting plane, equipped with a 300-horse-power Hispano-Suiza engine. Caleb Bragg's previous American altitude record of 20,250 feet, made with a Wright-Martin model airplane equipped with a Hispano-Suiza engine, had stood for a year and was only eight feet under the world's record of the International Aeronautic Federation made by Lagagneux on December 13th, 1913. The Government has accepted Captain Schroeder's record as official, thereby regaining our laurels lost when Lincoln Beachey's world record of 11,642 feet made at Chicago in 1911, was subsequently beaten.

Captain Schroeder's experience is interesting. While it was a comparatively warm day on the ground, several of his fingers were frozen and in removing his goggles for an instant for adjustment, his nose was also frost bitten. The intrepid aviator used a rubber hose direct from the oxygen bottle, regulating the supply by means of a valve on the bottle. The hose was placed in his mouth so that he could breathe air and oxygen at the same time. At intervals he pressed his tongue against the end of the hose in order to tell if the oxygen was still flowing. This method was quite satisfactory, except that the oxygen bottle and the rubber tube gathered about a quarter of an inch of frost, which made it very unpleasant. Captain Schroeder found the oxygen supply indispensable above 25,000 feet, receiving warning of this fact by a sort of drowsiness and mental depression, which were removed with the taking of oxygen. At the 29,000-foot level the temperature was recorded as 62 degrees below zero, Centigrade.

The Hispano-Suiza engine functioned perfectly throughout the ascension, and only stopped when the gasoline supply was exhausted. Captain Schroeder then volplaned down from his great height and landed at Canton, Ohio, over 200 miles from the starting point.

AIR FOR CLEANING STRUCTURAL IRON AND PAINTING

By A. E. Wilson

Painting over scale or the fine rust under the scale is labor and material wasted, as corrosion will continue as long as there is any rust under the paint. The only effective way to remove this rust is by the use of a sand blast. This method will remove all rust, dirt, etc., and leave the iron in a condition that will enable the new paint to stop further corrosion. The best outfit to use is a portable machine that is light and easily transferred in work cars and which can be set up on the job without blocking the main track or stopping trains.

In using the sand blast care should be exercised not to hold the nozzle too close or too long on the same place, as it will wear away the metal. The cost of cleaning by the sand blast varies according to the type of bridge to be cleaned, but it will average about $1 a ton, which is much cheaper than it can be done by hand.

The heavy scales of rust must be chipped off with hammers or air chisels, as the sand blast will remove them only by eating through and the men operating the nozzles are liable to go through too far and damage the iron. It is necessary to follow up the cleaning with a coat of good paint immediately, as corrosion starts very quickly after the use of the sand blast. All the surface cleaned should be painted before leaving the work at night, or it will be covered with a fine rust by the following morning.

As regards spraying of paint on bridges, personally I prefer the old fashioned way of applying a paint of medium weight with a good brush, except in places where one can not reach with a brush or swab. But in applying cold water paint or white wash on the interior of buildings or in the painting of concrete buildings I think spraying the material is the best and cheapest method. Concrete is so porous that it takes quite a little time to rub in the paint to fill up the pores, and unless you have reliable men they will skip over the outside of the surface and not fill it in, thus leaving it very uneven when finished. A portable compressor and tank for this work will pay for itself in one season if there are many concrete buildings to paint or white wash.

I would not recommend the spraying of stations or other station buildings. It is in pockets and other places that are difficult to get at with a brush, as on an I-beam bridge where the I-beams are so close together and it is impossible to get a brush or swab between them, that the sand blast and spraying machine do the best work.

In using the spraying outfit, the air pressure on the tank holding the material should not be more than is necessary to raise the material and cause it to flow slowly from the nozzle held in a working position. The air pressure at the nozzle should be just sufficient to atomize the material. The nozzle should be held about 6 in. to 10 in. from the surface of the work, and be moved back and forth with smooth and even strokes. Its operation is simple and any one with a little practice can cover a large area in a day.—*Railway Age.*

THE CAVALRY OF THE AIR

To institute a comparison between the cavalry of the land and the cavalry of the air is interesting and not altogether profitless. The air force can make no prisoners and can take no ground, much less occupy it, but it can do work which, for the cavalry, is impossible. It can go beyond enemy outposts; indicate his formations; see where he has his reserves, and what services he has in his rear. Aeroplanes can bomb the enemy on the march, in camp, and in fact everywhere and anywhere. It can destroy bridges, cut-up convoys, make roads difficult, compel the enemy to abandon enormous quantities of war material and thousands of prisoners. German aviation has been reduced almost to powerlessness. French machines now act in groups, and the mortality amongst enemy productions shows the effectiveness of the method. For example, the July 15 German offensive was perfectly known to the French. At Lassigny the enemy was bombed by 120 aeroplanes, and as these operated in relays, their work was continuous and effective. The air service did immense service in the recent battles of Champagne and Picardy, and of a kind that cavalry cannot do.

Aviators are always in the van. They prepare the way for artillery and indicate the precise spots where shots can best be placed. They also, in conjunction with the tanks, prepare the way for the infantry. When we get the mass of machines the Americans have promised, Germany may be conquered even from the air, for there is no more effective way of dealing with the Huns than by carrying the war into their own camps, towns and cities. The aeroplanes employed today are vastly different from those used at the beginning of the war. They have been immensely improved, and it would be difficult to say when perfection will be reached.—*Mining World,* London.

THE LATEST BRITISH AIRPLANES

It is stated, says the *Daily Chronicle,* that the Royal Air Force will soon have swarms of a new type of machine at the battlefront which is likely to add greatly to the difficulties of the Germans. This machine, a brilliant example of the constructor's art, is capable of carrying with its pilot and observer a great weight of bombs, machine guns, and other equipment, to over 20,000 feet, and in an extraordinary short time. Soaring, as the new machine will, above the average range of guns and German airmen, it can cross the fighting lines, drop its bombs, and return home swiftly for a new load. So fast is it, even at great altitudes, that long distances can be accomplished in the shortest periods, and bombing raids which with the older type of machine would, perhaps, need a whole day's preparation, will now be carried out within a couple of hours. Moreover, what is of the utmost importance, their engines are completely reliable, and the risk that they might fail when a hundred miles over the enemy lines—a risk too common with some of the earlier types—no longer exists. It says much for their supreme value that, so far, not one of this type has been brought down, in spite of the Hun's utmost efforts. When the weather will not permit high flying, as is often the case in the winter, these machines will fly low, and so great is their speed that all but the very fastest of modern scouting planes will be left behind them. For these machines the unmost skill and nerve are needed. The observer must not only be able to ward off hostile craft by accurate machine gun fire, but he must also have an expert knowledge of map-reading and aerial navigation, since when flying long distances at great heights it is extremely difficult to find one's way by any landmark.

Of a world's copper production of approximately 3,100,000,000 pounds in 1917 the refineries of the United States produced 2,262,000,000 pounds, or a trifle less than 80 per cent.

A firebrick cement, for which saving in time of laying the bricks and long life of the joints are claimed, has been placed on the market under the trade name of "amalgam." The bricks are merely dipped in the cement. This does away with the usual buttering or covering of the bricks before they are laid. When used as a lining it is claimed that the covering of the lining bricks with the cement results in an increased life of the brick.

According to information received from one of the leading East coast shipyards, says *Marine Engineering,* the best day's work on a shell with pneumatic riveting is 700 rivets of ⅞-in. diameter, and for hand work, under the same conditions, 430. An average day's work is considerably less than this, and may be taken as being 510 rivets with pneumatic riveters against 264 with a hand squad, for work on all parts of one ship.

In a recent discussion of the cost of oxy-acetylene welding at a meeting of steam railroad mechanical men some data were given to show that the average cost of welding by this process is about $1 per cubic inch of weld. The data covered welds using from 1½ lb. to

2¾ lb. of welding metal, with acetylene at 3 cents per pound, oxygen at 14 cents per hundredweight, welding metal at 10 cents per pound and labor at 42 cents per hour.

A new fruit containing a large percentage of oil has been discovered in the region of Torreon, and is known by the name of "chichopoxtle." Experiments show that 25 per cent. of its contents consist of oil of great value in industrial pursuits requiring a lubricant of high quality.

The United States Fuel Administration is desirous of securing catalogues of dealers in power-plant accessories. Publications of this kind should be addressed to David Moffat Myers, Advisory Engineer, United States Fuel Administration, Washington, D. C.

A Royal warrant announced that the Continental system of time—the 24-hour clock—would be brought into use throughout the British Army from midnight, September 30th-October 1st, 1918. The "time of origin,' that is, the time at which a message or dispatch is signed by the originator, will always be represented by four figures, the first two figures, 01 to 23, representing the hours from midnight to midnight, and the second two fingers, 01 to 59, representing the minutes of the hour.

Tungsten has the highest melting point of all known metals, namely 3350° C.; it is one of the hardest of the metals; it has the highest equiaxing, or recrystallization temperature after strain hardening, of all pure metals known. It is particularly distinguished because, when composed of small equiaxed grains, it is extremely brittle and fragile at room temperature, and when possessing a fibrous structure it may be ductile and pliable at room temperature. The common ductile metals act in exactly the opposite manner in this respect.

An ordinary potato may be used to tell which is the positive and which is the negative terminal of a circuit. Insert the two current-carrying wires into the freshly-cut surface. A green stain, due to dissolved copper, indicates the positive wire. If both wirese are surrounded by dark colored stains the current is alternating. If you haven't a potato handy, place both terminals in water. Bubbles will collect at the end of the negative wire. If the water is in a metal vessel be very careful not to let the wire touch the metal or a short circuit will be formed.

The method of awakening a heavy sleeper by sprinkling cold water on the face is one with which we were all more or less familiar in our youthful days. Usually, it is harmless and effective, but it has been attended with tragic results recently on a well-known goldfield. An oiler employed in the cyanide works was indulging in a siesta at a time when he should have been attending to his duties. It appears his foreman thereupon threw some water which was in a bucket in the room over his face, with the intention of arousing him. The boy woke up but was unable to walk and shortly after took ill and began to bleed at the nose. The foreman tried to bring him round but failed and ordered him to be sent to the hospital. While he was being taken away he died. It has been ascertained that the liquid in the bucket was not pure water, but contained some cyanide solution which is used at the works, and it is surmised that the deceased swallowed some of the stuff.

It is a well-known fact that at a height of 1 ft. from the water an object can be seen at 1.32 miles; at 6 ft. elevation the range of vision is increased to 3.23 miles, while at 10 ft. the horizon is increased to 4.16 miles. This in clear weather puts great limitations upon the sight of a submarine periscope, as all allied merchant vessels are keenly on the lookout for such, says *Marine Engineering and Naval Architect.* From the above it is also very evident that aircraft have extraordinary value in scouting for submarines, as at 25 ft. elevation an object can be seen 6.59 miles away; at 100 ft., the range of vision is increased to 13.17 miles; at 500 ft., the line where sea and sky meet is 29.45 miles away. At a mile high an aeroplane has a range of vision of 95.7 miles. At this height, with powerful telescopes, an aircraft can sweep an area of about 300 miles. In order to distinguish the camouflaged vessels of the Allies, the Germans have fitted their latest periscopes with ray filters, which clearly bring out the outlines of such otherwise invisible vessels.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 10.

1,278,127. EVAPORATING APPARATUS. John H. Fedeler, New York, N. Y.

1,278,222. VACUUM-CLEANER NOZZLE. Lynn D. Rudolph, Chicago, Ill.

1,278,237. EXHAUST-CONTROLLING VALVE FOR PERCUSSIVE TOOLS. Fred M. Slater, Easton, Pa.

1,278,314. FLUID-PRESSURE GENERATOR FOR TURBINES. Arthur Dix, Santa Maria, Cal.

1. In a fluid pressure generator, a generating chamber, means for delivering water thereto in a cone-shaped film, means for delivering air into the chamber through the apex of the water film, and means for discharging fluid fuel in a cone-shaped spray through the apex of the water film.

1,278,317. AIR-BRAKE SYSTEM. Frank H. Dukesmith, Meadville, Pa.

1,278,350. SHOCK-ABSORBER. Cecil A. Hubbard, Ann Arbor, Mich.

1,278,387. TIRE - CHARGING AIR - PUMP. Loren Risk, Minneapolis, Minn.

1,278,391. PULSATOR FOR MILKING-MAchines. Edward Schlukebier, St. Paul, Minn.

1,278,524. FLUID-PRESSURE BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

1,278,572. AIR AND GAS PUMP. Richard A. Bemis, San Bernardino, Cal.

1,278,593. DRYING AND AERATING MACHINE. Charles Edwin Clark, William Moore Clark, and Jonas A. Sparks, Elk City, Kans.

1,278,620. LIQUID-FUEL BURNER. Thomas B. Ferguston, Brooklyn, N. Y.

1,278,627. FLUID-PRESSURE STABILIZER FOR AEROPLANES. George A. Fowler, Jr., Thatcher, Ariz.

1,278,657. PNEUMATIC LUBRICATING SYSTEM FOR LUBRICATING THE FLANGES OF TRACK VEHICLE-WHEELS. Charles Frederick Hoofer, Seattle, Wash.

1,278,700. ROTARY COMPRESSOR AND VACUUM-PUMP. George C. McFarlane, Denver, Colo.

1,278,772. SHOCK-ABSORBING ARRANGEMENT FOR VEHICLES. Jean Paul Sinsou, Levallois-Perret, France.

SEPTEMBER 17.

1,279,067. APPARATUS FOR GRADING, SEPARATING, CLEANING, AND CLIPPING GRAIN. John W. Wright, Battleford, Saskatchewan, Canada.

1,279,085. ENGINE-DRIVEN AIR SYSTEM FOR DIESEL ENGINES. Gregory Caldwell Davison, New London, Conn.

1,279,115-6. VACUUM-FUEL-FEED SYSTEM. Webb Jay, Chicago, Ill.

1,279,308. CEREAL-GRAIN-HULLING SYSTEM. Frank Emenegger and Joel H. Westfall, Petaluma, Cal.

1,279,363. ELECTRICAL AIR-HEATER. Frank Kuhn and Jay A. Hand, Detroit, Mich.

1,279,379. VACUUM PROCESS FOR PRESERVING AND OTHER PURPOSES. William Steven Sellars, Brooklyn, N. Y.

1,279,388. PNEUMATIC TENSION-REGULATOR FOR AUTOMATIC MUSICAL INSTRUMENTS. Louis H. Maier, New York, N. Y.

1,279,460. AIR MOISTENING AND COOLING DEVICE. Samuel Shoesmith, London, Ontario, Canada.

SEPTEMBER 24.

1,279,536. AIR-BLAST OIL-STOVE. Alvah M. Griffin, Kansas City, Mo.

1,279,558. LIQUID - LIFT. Frank Edward Lichtenthaeler, Newton Highlands, Mass.

1,279,580. AIR - PUMP FOR WATER-DISTRIBUTING SYSTEMS. Theodore Peters, Ferdinand, Ind.

1,279,650. DIE-CASTING MACHINE. George Waldemar Bungay, Brooklyn, N. Y.

1,279,685. AUTOMATIC AIR-CONTROLLING DEVICE FOR GAS-ENGINES. Wade H. Guthrie, Charleston, W. Va.

1,279,786. PNEUMATIC VALVE-ACTUATING DEVICE. Henry Wm. Terry and John W. Fowler, Toronto, Ontario, Canada.

1,279,823. PROCESS AND APPARATUS FOR CAUSING PRECIPITATION BY COALESCENCE OF AQUEOUS PARTICLES CONTAINED IN THE ATMOSPHERE. John Graeme Balsillie, Melbourne, Victoria, Australia.

1,279,844. NUT - MEAT - CLEANING APPARATUS. Homer L. Cole and Fern S. Bishop, Santa Ana, Cal.

1,279,859. DUPLEX AIR-PUMP FOR CARBURATING OR GAS MACHINES AND THE LIKE. Arthur Grandjean, San Diego, Cal.

1,279,925. PNEUMATIC CUE. Ezra B. Smith, Chicago, Ill.

1,279,927. AIR - BRAKE ALARM - SIGNAL. Robert D. Smith, Brookline, Mass.

1,279,929. VALVE-GEAR FOR ROCK-DRILLING. William Charles Stephens, Carn Brea, England.

1,279,933. COTTON-PICKER. Louis C. Stukenborg,, Chicago, Ill.

1,279,981. AUTOMATIC BLOWER ATTACHMENT FOR PUNCH-PRESSES. Edward Calderio, Garfield, N. J.

1,280,010. PRESSURE-CONTROLLER. Nijah I. Garrison and Harry W. Steele, El Reno, Okla.

1,280,020. VACUUM-CAP. Charles Hammer, Queens, N. Y.

1,280,063. VALVE FOR AIR-COMPRESSORS, Etc. Frank L. Miller, Parkersburg, W. Va.

1,280,101. REFRIGERATING - MACHINE. David I. Davis, Chicago, Ill.

1. In a refrigerating machine, the combination of an evaporator, a low-stage compressor, to which the evaporator discharges, for initially compressing the gaseous refrigerant, a high-stage compressor to which the low-stage compressor discharges, a condenser to which the high-stage compressor discharges and discharging to the evaporator, means for introducing refrigerant from the condenser into the line of communication between said compressors, and means for mixing said last-named refrigerant with the gas passing from the low-stage to the high-stage compressor whereby the volumetric efficiency of the high-stage compressor is increased.

OCTOBER 1.

1,280,139. GLASS MANUFACTURE. Richard H. Bolin, Rochester, N. Y.

1,280,146. AIR-NOZZLE FOR TRACK-SANDERS. Elmer E. Bradley, Clinton, Iowa.

1,280,157. COMBINED AIR AND ELECTRIC TRIPLE VALVE. William George Canion, Baltimore, Md.

1,280,229. AIR-COMPRESSOR. William H. Hutchinson, Howard Lake, Minn.

1,280,276. CENTRIFUGAL AIR - COMPRESSION SYSTEM. Robert V. Morse, Ithaca, N. Y.

1,280,332-3-4. FLUID - PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.

1,280,420. CUTTING-TORCH. Frank Y. Dibble, Chicago, Ill.

1,280,500. SPEED - CONTROLLING APPARATUS FOR RAILWAY-VEHICLES. Lloyd V. Lewis, Edgewood Borough, Pa.

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Compressed air

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